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This book contains the proceedings inclusive of a peer reviewed section of papers presented at the 10<sup>th</sup> International Research Conference 2017 of General Sir John Kotelawala Defence, University Ratmalana held on 3<sup>rd</sup> and 4<sup>th</sup> August 2017. No part of this Publication may be reproduced stored in a retrieval system or transmitted in any form or by any means including electronic, electrostatic, magnetic tape, mechanical, photocopying, recording or otherwise without prior permission in writing of the publisher. The contents published in this book do not reflect or imply the opinion of General Sir John Kotelawala Defence University or any other agency of the Ministry of Defence of the Government of Sri Lanka. They reflect and imply the opinions of the individual authors and speakers.

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## FOREWORD

KDU International Research Conference (IRC) has been the platform for knowledge dissemination among local researchers for a decade. This year on its 10<sup>th</sup> anniversary IRC was held successfully under the theme of “Changing Dynamics in the Global Environment: Challenges and Opportunities” on 3<sup>rd</sup> and 4<sup>th</sup> August 2017.

The inaugural ceremony of the conference was held at the auditorium of Faculty of Graduate studies, under the patronage of Hon. Susil Premajayantha, Minister of Science Technology and research. Many distinguished guests, representatives from diplomatic missions and Tri-forces commanders also graced the event. Delivering his speech Hon. Minister stated the importance of research for the development of a country and the importance of identifying opportunities posed by the changing global environment.

10<sup>th</sup> IRC of KDU was signified by the awarding of honorary professorships to two internationally eminent Sri Lankan born scientists. This year IRC has honoured two great sons of its motherland Dr Bandula Wijey and Professor Chandra Wickramasinghe for their contribution to respective fields of science and to the mankind, by awarding them with honorary professorships.

This year IRC has seen a significance increase in the number of research papers submitted. Out of 557 research papers received from both local and international scholars, 365 has been selected for presentation through double blind peer review method. Each submission was reviewed by two independent experts in the filed before selecting them for either oral or poster presentations. Selected papers were presented in nine different research sessions namely; Defence and Strategic studies, Basic and Applied sciences, Engineering, Medicine, Allied Health Sciences, Computing, Built environment and spatial sciences, Law and Management Social science and Humanities.

On the first day of the conference, parallel plenary sessions of nine different disciplines were conducted with the participation of 46 experts delivering guest speeches

related to their respective disciplines. Technical sessions of this year’s conference drew more than 400 scholars from all over the country. International participants numbering more than 50, represented countries such as USA, UK, Australia, Hong Kong, Spain, Singapore, China, Germany, India, Thailand, Bangladesh and Pakistan.

This year’s IRC has conducted 8 pre-conference workshops and seminars on selected topics and one post-conference workshop. Both pre- and post- conference workshops were able to attract more than 1000 participants from all over the country.

The 10<sup>th</sup> IRC which drew more than 1500 participants on two days was a tremendous success. An increase in the web ranking of KDU has been seen following the conference. Benefits KDU gained through new international collaborations were immense. The impact it had on local R&D community was significant. It is therefore no doubt that IRC for the 10<sup>th</sup> consecutive year has shone the name of KDU while helping its effort to become a leading university in the region.

This book contains proceedings of the sessions conducted under the disciplines of Defence and Strategic studies, Basic and Applied Sciences, Engineering, Medicine, Allied Health Sciences, Computing, Built environment and Spatial Sciences, Law and Management Social Science and Humanities. Plenary speeches and selected research papers presented at the technical sessions of all nine disciplines have been included in this book. In addition, this book contains transcripts of all the speeches delivered at the inaugural session.

Therefore, this book will furnish all interested parties with an excellent reference book. I trust also that this will be an impetus to stimulate further research and development both in the local and international research community. I thank all authors, speakers and participants for their contributions.

**Dr KMG Prasanna Premadasa**

**Editor-in-Chief**

**Conference Chairman 2017**



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## WELCOME ADDRESS



### **Rear Admiral JJ Ranasinghe VSV, USP, psc**

Vice Chancellor, General Sir John Kotelawala Defence University

Distinguished members of the audience, ladies and gentlemen. It's my greatest pleasure as the Vice Chancellor of General Sir John Kotelawala Defence University, to deliver the introductory and welcome address of KDU IRC 2017. Significantly the 10<sup>th</sup> consecutive one organised by KDU. It is an important land mark in our journey as a national university of Sri Lanka. Ladies and gentlemen, let me first have the honour of welcoming our chief guest at this inaugural session of IRC 2017, Hon Susil Premajayantha, minister of Science Technology and Research in the government of Sri Lanka.

Sir I am greatly honoured and pleased to welcome you for this research conference as the most appropriate personality to open the proceedings of this international research conference. Your patronage as the minister of science technology and research will certainly encourage us as the organisers and all the researchers presenting papers at this conference. I appreciate your kind gesture of accepting our invitation and being here with us today to grace this occasion .

I also warmly welcome the Secretary to the Ministry of Defence Mr Kapila Waidyaratna, President counsel, The Chief of Defence Staff General Krishantha De Silva Commander of the Sri Lanka Army Lt General NM Mahesh Senanayake, Commander of Sri Lanka Navy Vice Admiral RC Wijegunaratna, Commander of Sri

Lanka Air Force Air marshal KVB Jayampathi, who represent the Board of Management of KDU along with Additional Secretaries of the Ministry of Defence. Let me also very warmly welcome world-renowned scientist Dr Bandula Wijey, who is also our keynote speaker on the conference theme 'Changing dynamics in the Global Environment: Challenges and Opportunities'. I am also pleased to welcome the internationally eminent scientist and an astronomer Prof. Chandra Wickramasinghe also to this conference. Ladies and gentlemen, I am sure that the presence of these two Sri Lankan born intellectuals at this conference will immensely inspire our young researchers to engage in serious research bring in glory for the motherland. Sir, we consider your acceptance of our invitations despite your busy schedules and coming all the way from US and UK is a great tribute to the defence services in Sri Lanka.

Also, it's my pleasure to welcome your excellency of the diplomatic corps, Vice Chancellors of national Universities, distinguished professors, scholars and eminent personalities specially those representing our friendly countries, senior officers of the armed forces and the police and all the presenters and the participants whose contribution will be crucial for the success of KDU international research conference 2017.

The selection of this year's conference theme 'Changing dynamics in the Global Environment: Challenges and

Opportunities' was done after several brainstorming sessions involving the academics as well as all senior officers of KDU and also the Board of Management. The theme is highly relevant and pertinent to us, particularly being a defence university as it opens avenues to deliberate on broader areas of concern in subject areas such as national security strategic studies, international relations, geopolitics etc. The theme would also be relevant in terms of the multidisciplinary research culture adopted by KDU. All the nine faculties of KDU dealing with various disciplines are able to address diverse issues in the face of changing dynamics in the global environment.

Ladies and gentlemen, professional integration is part and parcel of unique culture of KDU. We have officers of three services, engineers medical practitioners, lawyers, Surveyors scientists and academicians representing many disciplines such as Defence and Strategic Studies, Engineering, Medicine, Law, Management, Social Sciences and Humanities, Allied Health Sciences, Computer Sciences, Built Environment and spatial sciences etc. And they all are to foster KDU to maximise its services to the nation through multidisciplinary approach. So we believe that the customs of the research and also the outcomes of the research in these diverse domains will show us how best we could forge ahead in the face of changing dynamics in the world.

In conducting this conference on the selected theme and in sub themes under different faculties will bring professionals and researchers of different disciplines to a common platform to disseminate their valuable research findings. Further we establish strengthen partnership and collaborations across national and international researchers.

We encourage our researchers to excel in advanced research for the development of a secure nation for professional integration. Ladies and gentlemen, we have noted that our research conference is receiving increasingly large number of submissions each year, and it is heartening to say that in this year the conference secretariat received more than 550 abstracts out of which only 365 have been selected through a thorough double-blind peer reviewing process.

Let us look forward for highly fruitful plenary sessions, in which eminent researchers and professionals in each field will provide insights on selected subthemes, and for technical sessions with high quality research presentations.

Finally let me conclude by once again welcoming all the dignitaries, intellectuals and participants both foreign and local and wishing that the deliberations of this conference would mark a positive contribution for the betterment of Sri Lanka as well as for the rest of the world. Thank you.

## SPEECH OF THE CHIEF GUEST



### Hon Susil Pemajyantha

Minister, Ministry of Science, Technology and Research

Mr Kapila Waiydyaratne, Former Attorney General, President's council, and the Secretary Defence, Vice Chancellor of KDU, commanders of all armed forces, Dr Bandula Wijey, Prof Chandra Wickramasinghe, academic professionals, heads of institutions, conference participants, Ladies and gentleman. Today, is a red lettered day for the Kotelawala Defence University. You are successfully conducting the 10<sup>th</sup> International Research Conference of your university. To sustain such an effort is not easy. Specially, for a young university like yours. Research is the hallmark of a university. The two pillars of a university are the discovery of new knowledge and dissemination of such knowledge. It is through research and experimentation universities discovers new knowledge; and those who undertake only dissemination of knowledge without contributing to the body of knowledge in society falling short of a University. Vice chancellor, academics, professionals, ladies and gentlemen, therefore I wish to congratulate you the council and the senate of the university for their academic leadership in our higher education system. Your international conference has been able to attract a large number of research work of academics, more than 500 papers I understand, and out of 500 papers you have selected about 300, scientists, professionals with the participation of other resource personnel. Then you are from a wide array of fields in Sri Lanka and overseas. More interestingly, this conference is a leading opportunity available to members of the armed forces to present their academic work. The characteristics of a modern army is mastering of knowledge. In addition

to the mastering of weapons, intelligence and information. New knowledge represents a new weapon of strategy formulation. On behalf of the government of Sri Lanka, let me say that your research contributions are highly valued and the government would like to encourage the search for new knowledge and its applications. From the long list of research papers of this conference I see that you will analyze, discuss and debate on a wide range of issues involving science, technology, social sciences and professional subjects of which having a bearing on people's lives. The power of science to bring about change place a duty on the scientists and as well as the members of the armed forces to proceed with great caution and concern for the wellbeing of the common man.

I'd like to share with you a few thoughts about the implications of scientific advances and trends of emerging technologies on the future directions on the development of our country. Many new technologies are going to change our way of life as well. For an example, nanotechnology – the hyped technology of the new millennium. It will affect every industry from toothpaste to car tyres. From glass to clothing and from navigation to production of equipment, including military equipment. We'll need new strategies in the field of different areas. "Innovating Sri Lanka" introduced by my ministry in different fields, nanotechnology, biotechnology, robotics and artificial intelligence, genomics, etc. For an example, close to this university you find Arthur C Clark Institute of Modern

Technologies under the Ministry of Science, Technology and Research. Under this “Innovating Sri Lanka” program of my ministry that institution has already started training engineers, young and experienced, academic and professionals with a collaboration of University of Samara in Russian Federation. University of Samara; from sputnik to latest rocket engine; They are responsible for designing those engines. It’s a university with research and development. They pass it to Roscosmos, which is responsible for launching rockets, like NASA in United States. Recently I visited Moscow, with his excellency the president and I spend two more days and I went to University of Samara together with chairperson of the institution and the Director general and we signed an MoU with Samara University and Roscosmos. Our vision is by 2020 we want to send our own nano satellite to the orbit with the assistance of Roscosmos. And you find SLINTEC. One of my predecessors, Prof Thisa Vitharana, who pioneered that project about 6 years ago and in 2014 Nano technology laboratory commissioned in the Science Park in Pitipana, Homagama. Now you find 23 young PhDs of young Sri Lankans who have graduated from various universities in other countries are now working in that institution. They engage with research. It’s an ideal model for private public partnership. The chairman is from private sector, CEO from the private sector, four out of 7 directors are from the private sector. But the capital investment is done by the government. So, we are going to continue that. The second hexagon will be started before the end of this year. And in that science park, we are going to start a biotechnology laboratory. It is at the consultancy stage. Then we want to introduce robotics and artificial intelligence and genomics. With The president of commonwealth association, Prof Wajira Dissanayake, we are going to start a genomic laboratory in Colombo. The cabinet paper is ready by now. I just want to highlight as the ministry of Science, Technology and Research what we are doing at the moment. We are in a changing world. Science, technology are changing within 24 hours. So we want to mould our nation to match to that modern technologies and sciences emerging in the world. Dr. Bandula Wijey is with us today to deliver the keynote address. I met him few years ago in Houston. Very few Sri Lankans new about Dr. Bandula Wijey, until I invited him for STS forum attended by more than 700 Sri Lankan scientists and over 105 scientists from overseas which we had last September in Colombo. Dr. Bandula Wijey was awarded with “vidyajothi” by his excellency the president a few months ago, and we appointed him as the science ambassador in the United States. With his assistance, we managed to send a team of medical doctors to Houston,

to have discussions with one of the leading medical colleges, Baylor College of Medicine and Rice University in Houston and we have started strong links with these universities and other research institutions. Similarly, we should be able to help KDU to strengthen the relationship between the universities in other countries, specially the leading universities. In last 24 months, I managed to start another strong link with the CERN laboratory in Geneva, Switzerland, which mainly focuses on particle physics. So, we are becoming an associated member of the CERN laboratory. Almost all European countries are associated members of the CERN laboratory and also our neighboring India, and even Bangladesh. At the moment 4 undergraduates selected from 4 universities, Ruhuna, Colombo, Jaffna and Kelaniya will be in Geneva in few weeks to follow a couple of advanced courses. Last year we managed to send two and in the future, we will be able to give opportunities to KDU as well.

I started another link with one of the leading laboratories in the northern part of the America, in Chicago. As I mentioned, we have started strong links with leading universities and laboratories with my ministry and the institutions. For an example, a few weeks ago a team of 22 scientists representing medical field, environment, water management went to Beijing. Prof Sirimali Fernando, the chairperson of National Science Foundation is here with us today. She was responsible for organizing that joint workshop with Chinese scientists. So we managed to get the assistance of Chinese Academy of Science, one of the leading universities in China. And we have signed a MoU with the Chinese National Science Foundation. We had the first workshop in Beijing referring to CKDu and water purification projects and a research institution will be set up in Peradeniya. Likewise, with all the leading countries and with all the leading science foundations we have started collaborations with those institutions to promote science, technology and innovation.

Two weeks ago, I was in New York. UN headquarters. The ECOSOC, one of the subcommittees of United Nations is responsible for promoting social sciences, sciences, technologies and innovations now they are focusing on 17 SDG goals and 169 targets. Out of 17 sustainable development goals introduced by United Nations two years ago, all the member nations have to achieve those targets by 2030. As Sri Lankans, we have already achieved some of the targets, but not all goals. 6 goals are directly connected to science, technology and innovation.

Every year subcommittee of the United Nations organize a review meeting. I was in New York a month ago attending the second review meeting of STI for SDG. So, I just wanted to highlight what we are doing as the Ministry of Science, Technology and Research. Not only that, it is our responsibility and the duty to promote science and technology, specially the emerging technologies.

Now we have challenges. If you do a SWAT analysis, you will find what are the challenges, what are the weaknesses, what are the strengths we have and options we have. As a nation, we have good talents. We have shown it. We managed to solve a 30 years long conflict with dedication and with great sacrifice of human lives and resources in the year 2009. As a nation, we have more than 2500 years of written history. The irrigation, the medicine, engineering. We have shown our talents as a nation for years. Why can't we do it again. Because, we were under Portuguese, Dutch and British for more than 500 years. So as a nation we lost our talents. Even after the independence, during the industrial revolution and technological revolution which started somewhere in 1970s, we lost. Are we going to lose the modern technologies and talents? No! We have to get ready as a nation. With the guidance of his excellency the President and the government to emerge as scientifically, technically knowledgeable and with the new technological know-how, to mould our younger generation matching to the future or the 21<sup>st</sup> millennium. That's why we are always ready to assist all the universities to organize this type of research conferences. This year more than 9 universities sought our support and we helped them. Other than the institution under the Ministry of Science and Technology we have NASTEC, National Research Council, the National Science Foundation, National Institute of Fundamental Studies in Kandy. Every year they have research conferences. Here you have 9 faculties. I am amazed and very happy when I watched the video clip shown to us today. And I observed the organizing of this research conference. The dancing and then the other events so far is excellent. Because as a Minister of Education and for a short period of time as a Minister of Higher Education, I have attended many university events.

Not KDU, but our traditional universities. But here I see the difference between our traditional universities and your university. Quality is in everything. You maintain quality, not just quality, but total quality. And the perfection. When I observed the dancing here by your students, it's perfect. And you always maintain quality. I am wondering what is the secret behind this. I believe that is discipline. If you have the discipline as an institution, then you are perfect. And when u maintain quality, then your product after 4 years as doctors, engineers, managers, accountants, social scientists will be of good quality. That's what we need at the moment. It is the time that all the academics, professionals, as a government we need your guidance, your voice to develop our country. And I must mention that we have initiated a program that is to reform the STEM education in our country. Science, Technology, Engineering and Mathematics. It is high time to change the system, teaching methods, and upgrade our laboratories in schools, we have more than 1016 advanced level laboratories in our country. I don't want to mention the statistics of intakes to various faculties of the universities. We have 15 universities. 8 medical faculties.

Kotelawala Defence University is an example. I find many academics and professionals from overseas. We treat you as resource persons. This is an emerging university. You have few years of history. You have yet to do a lot of things and I request the Vice Chancellor and the academic staff of the university to engage more in research work. To mould our younger generation, we need STEM education reforms. In 2 weeks time, I am going to submit a cabinet memorandum to get the approval for the concept paper and the action plan. There will be a dialog in the society, among academics, professionals, and educationists on how to reform STEM education in our country. And within next few years to come you will find quality students to fill the gaps with innovative knowledge. So, with these remarks I sincerely hope your conference and the papers presented will result in useful finding which could help formulate evidence-based policies and programs for our country. With that hope, let me congratulate you again and wish you a very productive conference. Thank You!

## KEYNOTE SPEECH

### Purpose Driven Education



### Vidya Jyothi Dr Bandula Wijey

Ambassador, Science Technology and Innovation Sri Lanka, Texas, USA

Let me start with a proclamation, “No brain born into this soil be wasted without it being used for the development and prosperity of this nation”. So let’s do it. I want to share with you my thought about a very important and current topic. And the topic is “Purpose driven education”. It is my distinct privilege and honor to address this esteemed audience of intellectuals of Sri Lanka and from around the world.

Sri Lanka undoubtedly is the home of the intellectuals. We are the most literate country in Asia with more than 95% literacy rate. In fact, we are the envy of even the Western world. Sri Lanka is also one of the most beautiful nations on earth. The cloud kissing mountains, cascading waterfalls, the lush green mountain’s slopes, golden sandy beaches no doubt qualify Sri Lanka to receive that accolade. And even most striking than that are the most beautiful minds, beautiful brains that are here in this audience and in rest of the country. We are a blessed nation. Our nation is blessed with intellectuals; brains. And some of our brains have done very well here, and around the world. If I mention all the names I think I will not be able to get my message to you today because there are so many. Let’s talk about how we can utilize these brains. We must capitalize on our brain power and bring our country to the higher echelon of those nations who have come to the same levels of success. United States, Japan, China and many other nations, just to name a few.

Every nation has a unique economy based on its natural resources and the human capital. And education system

obviously plays a very important role and the development of the workforce and plays a very important role in the development of that nation. So, what would bring our nation, or any nation for that matter to be successful. And the most important factor, undoubtedly is education. So, let me elaborate on a few factors that contributed to the rise of the United States during the last 100 years and what transpired this development of United States to become a major innovator in the world. Of course, you know what I am going to say; purpose driven education. I used this word before education the word purpose because education should have a purpose, not simply learning something, but learning something for a purpose. So, let me highlight a very few important contributing factors, which I strongly believe has contributed to the success of the United States. I have lived there for more than 40 years. So, I have observed during the last 40 years how the education system developed, changed and keeps changing. First, education in America is a learning process, and not a teaching process. In fact, it is a lifelong learning process. Every year, at my age, I go back to classroom to get 16 hours of continuing education units in order to keep my license. This is true of all the doctors, engineers, lawyers, accountants and everyone. So, continuing education also plays a very important role in imparting the young people of the education that they will receive.

Higher education is carried out by instructors, not teachers. If you google, or go to a website of any university, look for the courses you will never find the teacher for the course is Dr. so and so. It’s always the instructor for the

course. We instruct, not teach. I remember my first day of school, with a brand-new notebook, new ballpoint pen. Sat in the class, at the time Professor Willcox. He came to class and said "ok let's study the first three chapters, your test will be two weeks from now". And we waited for him to teach it, but only thing I wrote was the names of the chapters I had to study. That was in 1974. So, I realized very quickly that I will have to dance to a new tune. The process of self-learning got started on that day. Instructor guides the student to learn material by themselves, not from the class teacher, but also from the surroundings. By interactions with other students, being hands-on from outside the classroom. The student is soaked in the entire learning process. Students are encouraged to express their opinions, trust themselves, be open to new solution, learn to handle unclear and conflicting information.

Consider things from different viewpoints, seek new information and review the way they think. Classroom is a place to assimilate skills through open discussion of the subject via a dialogue, not a unidirectional monologue, where you receive the information. Students are given problems to solve. Learning is by questioning and by solving problems. And it should be done and, it is done individually and by teams. And it is very important to get to engage the student to work with teams in order to gain their education. In United States, we call it the 'Problem-based Learning' or PBL for short. Started about 20 plus years ago, all medical schools today in the United States use PBL as the system of educating the medical students along with another process called ILS, Integrated Learning Systems, where you learn about a subject in light of all the other subjects. You are not simply learning anatomy, you are learning anatomy in light of other fields like physiology, biochemistry, pathology and various other. So, they are not learning this in compartment, they are learning it all together, how one area affects the other. Students acquire skills by actually solving real life problems, not learning theory. Students appreciate the principles learned in life of actual use, not assumed use, not by plugging values or numbers into a formula. Emphasis is on fundamental reasoning and critical thinking rather than theory and acquiring knowledge. We also have embraced the 21st century methods. Today we extensively use technology. Everything is on the web. Your subject material is on the web. The teacher is narrating his instructions on the web, so the student can learn if he can go to school or classroom or he can stay home and learn the same thing. And if the student doesn't understand something he can always rewind and listen to the narration again and again until he understands it. When he goes back to the classroom,

he can have a dialogue with the teachers. Can say them, I don't understand this part, I need you to explain that to me. When it is done in the classroom you know, when the teacher keeps teaching (or in the United states when the instructor keeps instructing), you may miss something you cannot stop him and say go back over and over again, because there are other students who probably have understood it. So, using technology is one of things that has happened. I have a course, my course that is on the website. The students have a username, password. They log in and learn the materials from the web.

Second point is education is broad-based. Education is not limited to two or three subjects. And one of the most important things is the inclusion of liberal arts. Liberal arts are a main component of the American education system. The first two years of any degree program is all about liberal arts. If you are in a course to become an engineer, the first two years you will be learning sociology, political science, economics, various other subjects in addition to the subjects that are for that field of engineering. Research has shown that successful inventors and entrepreneurs have a broad knowledge base. This in my opinion is the main reason, more than any other reason for the technological advancement enjoyed by the United States. The broad-based education hands down.

Thirdly, in the United States we emphasize skills than knowledge. Knowledge gets old. Knowledge I received in my high school years doing advanced level is now old. Most of that is not the same. Why should I pay so much importance to knowledge? Because knowledge itself keeps changing. Instead, we encourage the development of academic skills, where they learn to learn. The students must learn how to acquire knowledge. Not to accumulate knowledge. I see this in young people in America. My students, my employees, my colleagues. They have learned to learn. To come up with information and through that information, provide solutions on things that they had no idea before. The last few years I have been working with a lot of young doctors and engineers because I am an advisor in Texas Medical center incubator. So, I see how they function in their ability to learn things that they have no idea about and use it where they need such knowledge. This is one of the most important and interesting facts in the American system, and I am a case in point. Without any medical background, I am in medical research.

Students are equipped with skills to acquire knowledge rather than accumulate knowledge. Students are tested on critical thinking skills, not how much knowledge they

possess. There are no knowledge based questions. Asking students questions that stimulate their mind and testing their ability to solve real- life problems.

Fourth, the culture of research. Research in America starts in the kindergarten. kindergartener are asked to do independent research. You might be thinking what would a kindergartener do as research. I have two sons and when they grew up I went through this process. When they were in the kindergarten they were supposed to write research about their family. What's your father, what's your mother, where do they come from, where do you live, what do you eat. It promotes the asking of questions. They come and ask what do you eat thatthi, or what kind of job you do. It stimulates them to ask questions. So, developing this culture of questioning is obviously, as you all know, is a prerequisite for one to excel in research and become an innovator or inventor. And this is true irrespective of the field of the study. Whether you are an economist, whether you are a biologist, or a medical student is immaterial. Everyone has to do research. In most courses, the instructor is going to ask to write research papers. Two or three sometimes in a semester. So, they learn how to do research and it starts very early in their childhood.

Lastly, one of the most important aspects of learning education is the development of culture of the entrepreneurship. All American universities have this culture, where student develops new business concepts, develop products, obtain patents, raise money to start business, write business plans, while they are still in school. Rewarding those students who bring up new ideas and bringing them to future is a norm. As I said earlier, in the Texas Medical Centre which being the largest medical center in the world, with economy of eighty seven billion dollars, we have a large number of incubators and hope to bring in similar incubators to Colombo, Sri Lanka. This training brings another interesting point when these students start a project, which we normally call a start up, is done by teams, not by one person. And it's done by people by different fields. In a typical start up you will have a medical student, engineering student, economic student and students of various background who have joined their hands to start this new project. So that brings a richness and value to the start up, rather than just one person with one focus with one mindset. It's assembly of all different ideologies, all different knowledges, all different skills in the process of the business start up. Such entrepreneurship is at all levels in the education process. I think every so often you have heard about the lemonade stands, because sometimes it comes up in news that some little kid is

having a lemonade stand in the neighborhood and may be they didn't have a city permit and police would give some sort of a warning. That is children who are in the third grade. So, entrepreneurship starts very early.

Once they graduate from a university, who have undertaken the startup culture, who have soaked themselves in the concept of starting business, what do you think they will do? They are going to be the CEO of their company and not look for job somewhere else. This is one of the most important aspects of bringing entrepreneurship starting from the elementary school. Now you of course have heard about Facebook, Apple and so many companies in the Unites States. These are good examples of start ups. They did that while they were in the university or some them not even in the university. So there are a lot that we can learn from the United States. I just mentioned a few. United States is a very interesting country. There are no natives. We say there are no natives, there were few. What we mean is the current population are all immigrants or mostly immigrants.

We are from all over the world. There are the white Europeans from UK, the non-white Europeans, the Asians, the Africans. We are from all over the world and assembled in the Unites States. It's a melting pot. Along with immigration, we have brought many cultures and work ethics, skill sets and various other assets to America. But we have confirmed on one thing very quickly, and that is skill-based education. Most of the people I work with, I know other than the ones who are born in the United States came from some other country, India or China or Pakistan, who were in a different system including myself. But after we arrived, within a year our mind has changed, our mindset has changed, our thinking has changed and we concentrate more of a skill-based learning than a knowledge-based learning.

So finally, let me plant a thought in your mind. In the US, when I meet someone at a party or an event or even in an elevator, the person usually assumes that I am a doctor. The clue is my brown skin. Someone few years younger looking than me, they think I am an IT person. Why?

Because our good friends, of us here have done such a great marketing job and they have established themselves as smart professionals specially, in medicine, engineering and IT. You don't have to go too far. Every tech company CEO is an Indian. It's true that they are technologically savvy. They work hard for it. But more than that they set their mind to one thing. They wanted to brand themselves. So ladies and gentleman, branding is very important if



you want to come to the echelons that I discussed in the beginning of my talk. When we think of the United States or the Americans, we brand ourselves as innovators. Just about every innovation, maybe one or two less has been done in the United States. Whether it is in medicine, engineering, space science, biology we innovate. We innovate because of what I just said. Koreans have done it with their electronic equipment, televisions, cell phones, cars, plastic surgery. Israel with unique advanced weapon systems and medical devices as most of you would know about that. Swiss with precision watches and machines. Germans with their engineering. Chinese have branded themselves for mass manufacturing and of course their high speed trains. So, branding is very important for a country to get acceptance as a global leader in a given field. If someone in another country is looking for a product or service, like in my case, sometimes I want to get somebody to build a stent, My mind goes straight to China. I don't think of India or I don't think of Pakistan or Indonesia. I need to get things made. Where should I go? China! So, when somebody thinks of something your name has to come up number one in the list. As branding and simply they say we want a soft drink Coca-Cola. People say they need a Coke but they go and drink Pepsi, but they think

of Coke. Therefore, branding is very important. What I am asking you to do is to think what can we do to brand us in Sri Lanka. Learning from others, we in Sri Lanka must brand ourselves. So, what can we do and what should we do? This in my mind can be done by reaching the pinnacle of education. Based on our resources, our talents, the man power, what is it in our basket that we have that we can use to brand ourselves. "Education". We can and we must become the education hub of Asia. Now I already see that happening at KDU with a large number of foreign students. In a few years, most of these students in Asia, and I believe some from Australia, and it won't be too long when the word gets out United States. American students who pay five hundred thousand dollars to become a doctor will spend fraction of that can come to KDU to become a doctor. So, we can brand ourselves by creating Sri Lanka the education hub. Provide an education parallel to none, practical, skill-based, well-rounded innovation capable, enterprise directed and ladies and gentlemen uniquely purpose driven.

Thank you very much.

## GUEST SPEECH



### Prof Chandra Wickramasinghe

Director of the Buckingham Centre for Astrobiology, University of Buckingham; Honorary Professor, University of Buckingham; Visiting Professor, University of Peradeniya, Sri Lanka; Board Member and Director of Research, Institute for the Study of Panspermia and Astroeconomics

The Chancellor vice-chancellor of KDU, Admirals generals heads of the various Armed Services Armed Forces distinguished guests ladies and gentlemen, it's my pleasure to be here and to give you this address this morning. I would like to begin by congratulating KDU on the exceedingly wide range of academic as well as professional disciplines that you have brought under the remit of a single Defense University One would normally expect a university bearing such a name to focus on perhaps military history, strategy, military strategy, science of weaponry and so on but the concept of Defence itself has a much wider range of interpretation and it is to these that you have turned to expand the remit of your University. The primary aim of a well-established state is to ensure the defence and security of its citizens against attack from other states and in this regard an Army, Navy, Air Force and so on have their due place. There is also a need to defend law-abiding citizens from other citizens and here institutions like the police and the judiciary play a role. Finally, there must be a system of defense in place to protect citizens against the state itself and here of course, we require the judges and the judiciary to be independent of the state. Finally, we can even think of even broader concept of defense that are the responsibility of an enlightened and civilized society. Defense against ignorance, bigotry, superstition which all come under the heading of education and science.

Our ancestors in the dim distant past would have watched the pristine unpolluted night skies of the desert, and would surely have yearned to understand their connection with the heavens and the external universe but they couldn't

quite grasp it in those days they would have asked the most fundamentals of questions that we continue to ask even today, how did the universe begin, how did life begin, where do we humans fit into this grand scheme of things. Answers to these questions have evolved over centuries and millennia of history moving from superstition, speculation, ultimately to scientific fact. In the 4<sup>th</sup> century BC the Greek philosopher. Aristotle was a pupil of Plato and the tutor of Alexander the Great, made two assertions that were to change the course of history. The first was that the earth was the center of the universe; stars, planets and all heavenly bodies revolved around a central earth. The second aristotelian principle was that life of every form arose and continued to arise spontaneously from nonliving inorganic inanimate matter on the earth. Both these assertions turned out to be wrong but Aristotle was a towering figure in western philosophy; so, his wrong views, his totally wrong views held sways for centuries.

The first Aristotle principle of an earth-centered universe, a geocentric universe that was adamantly held and defended set back the progress of science for many centuries in the Western world. Only after the completion of the most traumatic of scientific revolutions, the Copernican revolution in the 17<sup>th</sup> century, was the geocentric philosophy was finally abandoned. The second Aristotelian principle is of life being centered on the earth and arising spontaneously on this planet and this has been even more difficult to overturn. It has dominated philosophy and science for over 2,000 years and in many ways still continues to do so. The most famous challenge of

spontaneous generation came from the work of the French biologist Louis Pasteur in 1859. From his experiments on the fermentation of wine and the souring of milk, he demonstrated that life seems always to be produced from life that existed before leading to the '*dictum Omni ex-vivo*' meaning, all life comes from life. This did not however deter later scientists like Perrin Holden and Stanley Miller In the 20<sup>th</sup> century from developing their theory of the so called primordial soup or the primordial sludge pushing back the elusive event of spontaneous generation of life to a remote perhaps unknown geological past, despite the paucity of supportive facts and a growing body of contrary evidence, this theory stubbornly dominates science and cripples Its progress even at the present time. Pasteur's life from life's dictum manifestly continues to the entire geological history of the earth all the way back to the time before the earth itself existed as a planetary body. There is now no doubt whatsoever that life did not and could not originate on the earth. The oldest evidence of life on the earth, has very recently been discovered in a rock formation in Australia that formed 4.2 billion years ago? That's a very long time ago; and this is very shortly after the earth itself had formed and when comet impacts were frequent and ferocious. So the evidence is growing that comets carry primitive life that can see the planet or planets like the earth at the very first moment that life friendly conditions prevail. On this picture, every single life form on the earth from the humblest single-cell organisms to the most complex plants and animals has an antiquity that stretches back as far the time as we can imagine. All our DNA essentially came from space carried in cometary bodies in the shape of viruses, bacteria and even simple single-celled organisms.

They Originated in ways that we still do not fully understand but all this took place certainly not on the earth but in the widest possible cosmic context. The beginnings of the theory of cosmic life of which I was associated with, dates back to the middle of the 1970s when as a young researcher in Cambridge, I was trying to understand and unravel the composition of cosmic dust. My investigations soon led to the conclusion that this dust was composed mainly of complex organic matter that made up about 1% of the mass of the entire galaxy. In the mid-1980s the late Sir Fred Hall and I argue that comets also carried vast quantities of organic molecules and when this comet (Eg. Halley's comet) reappeared in 1986 measurements from space actually showed that to be true. We explained the presence of organic molecules in space and comets as being the byproduct of living processes bacteria and viruses in various states of decay and degradation. More

recent studies of comets in the space age including the recent rosetta mission to a comet called 67pcg confirmed this point of view. Complex organic material escapes in these Jets from this comet such as this comet, and more recently in a comet called Lovejoy we found a profuse emission of sugar and methyl alcohol. The kind of alcohol that you have in whiskey or in wine as a rate equivalent to about 300 bottles of wine per second. Nobody has been able to explain this process except by invoking the process of fermentation. So, fermentation seems to be the only rational explanation for this type of result.

So there's now no doubt whatsoever the comets brought the first life to earth at 4.2 million years ago, and further encounters with comets continues to bring new bacteria and viruses that contribute to the evolution of life on the earth. Geologists have known for a while that a great surge of complex multi-celled life appeared suddenly on the earth about 540 million years ago, this is the so-called Cambrian explosion of life and it is to this event that all of us and all plants and animals can trace their origins and crucially this point in time also marks the period that we recently discovered when the earth and the solar system was actually plowing through a giant cloud of cosmic dust with very frequent impacts of comets. Recently it's been also found that the DNA of all life forms including ourselves carry viral footprints that link us to developments at this time, so Darwinian evolution is then relegated to a fine-tuning process selecting the set of offspring best suited to local niches and this is a hard pill of course for conventional biologists to swallow. Conventional biologists trained in the narrow Darwinian point of view. But these are the emerging facts. And the sooner we admit them the better. Recent advances in microbiology including the discovery that many types of microbes can withstand the harshest Imaginable environments, all points to their space origin. Plant seeds and even small microscopic animals called tardigrades have been shown to survive space conditions on the International Space Station which orbits at a height of 400 kilometers above the surface of the earth. There is no Darwinian sense what so ever by which these extreme survival properties could have arisen by evolutionary processes confined to the earth. Only in the context of an open cosmic system with an imperative need for surviving space travel could all such properties be understood.

One of the most exciting areas of modern astronomy is the search for planets that are similar to the earth, orbiting the distance stars. Many studies have recently shown that there are huge numbers of such planets. In a system called Trappist 1, a star that is 40 light-years away, seven habitable planets have been discovered.

The nearest planet outside our own solar system is around a star called Proxima Centauri which is just four light-years away and four light years away is just almost in our backyard. The currently estimated tally of earth-like planets in our Milky Way system runs into some hundred billion almost one for every sun-like star. It follows therefore, the life of all types and forms that are known on the earth ranging from bacteria to plants and animals and even intelligent life must to a high degree of probability be all pervasive and connected interconnected In this way from one planet to another. Here on the earth our ancestral line of the descent that led through primates and anthropoids to *Homo sapiens* over 100 million years ago shows clearly the relics of repeated viral and retroviral attacks, presumably similar to AIDS. At each such viral attack the evolving line was almost completely crushed leaving only a small surviving immune breeding group to carry through with a relic form of the virus that is tucked away in its genome. It is the expression of such viruses over time that marked the progression and the branching points from early primates to modern *Homo sapiens*. There is now little doubt that viral sequences thus added provide evolutionary potential that led to new genotypes, new species at one end of the scale and to new traits and capacities to express our genes in novel ways at the other. It is becoming clear that our entire existence on this planet is contingent on the continuing entry of cosmic viruses entities which we had hitherto thought were merely vehicles for disastrous pandemics of disease. The positive role of such incoming viruses to evolution is only just beginning to be revealed. It also cannot be denied that bacteria and viruses coming to the Earth from space could sometimes pose serious threats of pandemic disease not only to humans but also to plants and animals. With all the data that is currently available across a wide spectrum of disciplines. I believe there is now an urgent need for the possibility of bacterial and viral ingress from space to be taken seriously.

I cannot illustrate this better than by quoting from an article by Dr. Loui Weinstein. Dr Weinstein published in the New England Journal of Medicine on the 6th of May in 1976 in which he reviewed all available data relating to the influenza pandemic of 1918, 1919 that caused some 30 million deaths worldwide; And this is what Weinstein said the influenza pandemic of 1918 occurred in three waves the first appeared in the winter and spring of 1917-18 the lethal second wave, started at Fort Davens in Ayer, Massachusetts on 12<sup>th</sup> of September 1918 involve almost the entire world over a very short time. Its epidemiological behavior was most unusual or the person to person spread

occurred in local areas the disease spread on the same day in widely separate parts of the world on the one hand, but on the other took days to weeks to spread relatively short distances and so on and he ended it by saying it was present for the first time at Joliet in the state of New York four weeks after it was detected in Chicago the distance between those areas being only 38 miles. The crucial statement here is that it is detected in Boston and Bombay on the same day with no air travel possible in 1918 simultaneous first strikes in Boston and Bombay is very strong evidence of a component of the virus falling in from space. From an examination of other historical pandemics. It is clear that conditions permitting the entry of pathogens from space may have been involved in many instances on record. During the past two decades tantalizing evidence of microbes currently entering the earth has accumulated but has been largely ignored or is not being pursued. such data as is presently available was acquired relatively inexpensively in projects that involve balloon flies to the stratosphere and the recovery of in falling cometary dust. The first in a series of such experiments that I was involved in collaboration with the Indian Space Research Organization was carried out in 2001 and 2006 with staggering results indicating that the inflow of microorganisms to the earth may be at the rate of some 1/10 of a ton per year. A huge amount, recently a group of Russian astronauts have reported microorganisms on the outside of the International Space Station at a height of 400 kilometers and there is now no argument whatsoever about any possibility of terrestrial contamination. This is if accepted and proved, will result in direct and unequivocal evidence of microbes arriving at the Earth from space. Perhaps more expensive and sophisticated investigations need to be carried out urgently if you are to prove beyond doubt that these microbes are unequivocally alien. The sad truth is that funding for such vitally important experiments is impossible to secure, compared with other space projects for solar system exploration. The budgets involved for a project like this are trivial but scientific and societal payoff could be huge.

From what I have presented in these few minutes. I maintain that we cannot afford to ignore such evidence. Measures must be put in place to monitor the stratosphere for incoming potential pathogens before they fall to the ground. In the event of a threat being discovered preventative measures such as the production of appropriate vaccines could be put in place in this way. It may be possible to avoid the worst consequences of any future pandemic that could threaten us in the future. The reluctance of some scientists to endorse these discoveries

lies not in the quality of the data involved but in a desire to maintain a conservative position, conservative Aristotelian position in relation to life on the earth. Although the earth was demoted from its privileged physical position at the center of universe over 500 years ago and not without anguish, the trench regard life is being centered on our home planet has persisted almost to the present day, But a paradigm shift with far-reaching consequences is unquestionably imminent.

In this lecture in this talk I only had time to deal with a very few of the strongest pointers to our cosmic ancestry. Our ultimate goal must be to confirm that the evolution of life takes place not just within a closed biosphere on a minuscule planet Earth but extends over a vast and interconnected volume of the cosmos. If it can be firmly established that we are not alone in the universe and that we are in fact the product of an evolutionary process that

is not confined to Earth but operates on a grand cosmic scale the implications for humanity would be immense. It will herald a sociological transformation more profound than any that has happened so far in human history. The supporting facts are all in place waiting to be correctly analyzed correctly pieced together into the grandest panorama that we can imagine. Enticing new vistas are opening up for research before our eyes, it will be the privilege for future generations to explore. I would like to end with a quotation from a sonnet by the American poet Edna St. Vincent Millay from her book on sonnets entitled 'Huntsman what Quarry' and this is the poem which is highly relevant to what I said; "upon this gifted age in its dark hour, Rains from the sky a meteoric shower of facts... they lie unquestioned, uncombined. Wisdom enough to leech us of our ill is daily spun, but there exists no loom To weave it into fabric. Thank you very much.

## VOTE OF THANKS



### **Dr KMG Prasanna Premadasa**

The Conference Chairman, KDU International Research Conference 2017

Honourable Minister, Science Technology and Research, Mr Susil Premjayantha, distinguished guests, ladies and gentlemen Good morning. It's with pride that I stand in front of you today to deliver my speech at the end of this very successful inaugural session of KDU international research conference. Today, KDU made history, firstly it has been 10 years since KDU started its international research conference. For a decade KDU has been a platform for both local and international researchers to share their knowledge and to form and to make collaborations. Therefore, as it always has been for its 30-year history KDU rendered its service to the nation untiringly for its development. And I am proud to be part of it in this special occasion.

Secondly, in its 10<sup>th</sup> anniversary KDU IRC has honoured two great sons of its motherland. Awarding honorary professorships to Prof Bandula Wijey and Prof Chandra Wickramasinghe. We are honoured that these two great gentlemen and the scientists are now part of KDU. This year as our Vice chancellor mentioned we have received more than 550 papers for selection and we have invited more than 50 dignitaries from world over and I expect more than 1500 participants for various different sessions organised for today and tomorrow. Therefore, being the conference chair of this year's conference was

very demanding. But I was lucky that I had hundreds of helping hands. Out of all, the assistance and the guidance I received from our Vice Chancellor Rear Admiral Jagath Ranasinghe and our deputy Vice Chancellor Brigadier Indunil Ranasinghe made these all possible.

In addition, I have received assistance from numerous individuals in various capacities to make KDU IRC 2017 a success. I thank them all for what they have done. The support we received from the co-organisers of this event, Ministry of Science Technology and Research, and National Science Foundation (NSF) was immense. I would like to thank Hon. Minister Susil Premajayantha and the other dignitaries from the ministry for their support. Finally, I would like to thank my two co-secretaries, who has helped me in various aspects to make this event a success. Mr Kanchana Wijesinghe and Miss Thiruni Adikari. And also, I would like to thank all foreign delegates who came from all corners of the world to take part in this event despite their busy schedules.

Ladies and gentlemen, I hope you will all listen, interact and be part of knowledge sharing and dissemination in your respective sessions. And I hope you all will have a most memorable time at KDU. Thank you.

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# *Defence & Strategic Studies*

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“Changing Dynamics in the Global Environment:  
Challenges and Opportunities”

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*Plenary  
Speeches*

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# CHANGING DYNAMICS IN THE GLOBAL ENVIRONMENT: THE MALDIVES STORY

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**Abstract-** This paper analyzes the paradigm shift in the national security and the impacts this global change to the Maldives, how the nation could overcome the changing dynamics. While national security has traditionally been centered on the strategies of leaders in their pursuit of national interests, modern day threat spectrum has evolved to include interstate conflicts, civil wars marked by genocide, abuses of human rights, attacks on civilian populations by terrorist organizations, the proliferation of weapons of mass destruction, global pandemics, and the catastrophic effects of global climate change.

This century has presented distinct and extremely impactful global events: from evolving and increasing terrorist attacks to civil wars, democratization movements across the Middle East, and refugee crises. In the backdrop of this global myriad of conflicts and challenges, Maldives needs to adapt in order to face and overcome these security threats.

The threats emanate from the polarization of extremism and liberalism when it comes to religion, the economy's overdependence on tourism, the lack of diverse industries to support the economy, and climate change. This paper looks at some of the solutions to address the said issues by addressing the concern of rising extremist ideologies through rehabilitation programmes, and planning and developing sustainable economic projects from a holistic and inclusive approach.

**Keywords-** Security, Maldives, Threats

## I. INTRODUCTION

National security has traditionally been centered on the strategies of leaders in their pursuit of national interests,

with a focus on military, diplomatic, economic, and informational instruments of power. This century has seen that the number and character of threats have become more numerous and complex, with some threats crossing national boundaries and challenging the well-being of humanity as a whole.

The modern day threat spectrum now includes interstate conflicts, civil wars marked by genocide, abuses of human rights, and attacks on civilian populations by terrorist organizations, the proliferation of weapons of mass destruction, global pandemics, and the catastrophic effects of global climate change. There is a paradigm shift in the notion of security.

The traditional notion of security was deemed too narrow because it ignored the degree to which ordinary people felt threatened by day to day issues like crime, hunger, disease, and environmental hazards. While the traditional definition of security remains important, the broader concept of "human security" is the main focus of governments in the twenty-first century.

In today's increasingly globalized world, the Maldives stands at crossroads with respect to its socio-economic transformations, ideological transformations, and environmental degradation. How well the nation of Maldives would cope with the aforementioned changes is a question all Maldivians ask. The objective of the study is to discuss the main challenges faced by Maldives in the security environment and socio-economic, religious, and environmental arena and recommend paths that the country could follow to reduce any adverse impacts.

## II. METHODOLOGY

This research is a qualitative analysis of the changing global environment and its effect on the Maldivian security environment. Major socio-economic, ideological, and environmental changes that accelerated in this century were analyzed with its implications to the Maldivian security environment. Some research documents in the above-mentioned fields were analyzed with its effects and repercussions in a Maldivian context as it relates to a small island state with a small population with limited resources and a limited economy.

Trends and patterns were analyzed to find and weed out contradictions so that reliable accepted trends agreed upon by the mainstay of intellectual community were discussed.

The research is limited in that there are very few researches done on the changing dynamics of small island states and Maldives is unique amongst even small island states with regard to its homogeneity and geo-strategic location in one of the most crucial Sea Lines of Communication (SLOCs) in the Indian Ocean.

## III. DISCUSSIONS AND RESULTS

### A. Changing Security Dynamics of the Twenty-First Century

This century saw extremely important events in the security spectrum of the world. These include, but are not limited to the 9/11 attacks and the global war on terror, the rise of non-state actors like Al Qaida and ISIS, the democratic movement in the Arab world known as Arab Spring, the civil war in Syria, and mass exodus of refugees to name a few. After the end of the Cold War, the bi-polar balance of power gave way to a global hegemony: the United States of America. They were especially superior in conventional warfare. However, 9/11 proved the high impact of non-state actors and transnational nature of threats. Terrorist attacks orchestrated and carried out by various non-state actors across the world following the 9/11 attacks changed the threat spectrum. Terrorists had a new modus operandi: inflict as much damage as possible until killed. This determinant tactic made the superiority of the United States' superior conventional power inadequate to effectively address the issue, and regard it as a matter of chancing, and eventually winning, the hearts and minds.

The militaries around the world need to understand that these transnational non-state actors will not try to directly engage them in a military conflict, but would rather try to conduct attacks on a wide variety of fronts using different techniques and tactics that does not call for a military response. The Global War on Terror and its ineffective use in Afghanistan and Iraq shows that the use of military as the preeminent element of national power should be limited to the first phase of the operations. The failure to understand the situation on the adversary's terms lead to a failure in the overarching national strategy in both nations. Today the common people of both Afghanistan and Iraq feel less secure than they felt before the invasion and the security environment in both nations have deteriorated further.

In today's globalized world, threats faced by nations are global in nature, most of the attacks are carried out by terrorist organizations of a global reach, which do not respect geographical boundaries or religious beliefs or ethnic makeup of a society. To counter these threats, it is important to strengthen the intelligence organizations and put mechanisms in place for inter-agency and international collaboration amongst the intelligence communities of the world (Carlson, n.d.). The movement of terrorism related finance, weapons trafficking, and terrorist communications can be thwarted if intelligence communities share timely actionable information across the board.

### B. Global Maritime Security Domain and its Implications to Maldives

Maldives, being a nation that comprises of 99.7% ocean, depends on safe, secure, and clean seas and oceans for prosperity and peace. It is through adequate maritime security that we can maintain the rule of law in areas beyond national jurisdiction and protect our seas.

Though there is no set definition of maritime security, it is commonly accepted as absence of threats such as maritime inter-state disputes, maritime terrorism, piracy, trafficking of narcotics, people, and illicit goods, arms proliferation, illegal fishing, environmental crimes, or maritime accidents, and national and manmade disasters.

Maritime security is a major challenge for the poorer coastal and island countries of the Indian Ocean Region. The Indian Ocean has an area of around 73.5 million square kilometres and is the busiest trade route of the twenty-first century. The Indian Ocean region comprises all the littoral and island states of that ocean. There are

states of Indian Ocean. They are eighteen in Africa, eleven in the Middle East, seven in South Asia, six in Southeast Asia, five island states, and Australia.

Managing maritime security is a challenging endeavor that requires cooperation between regional countries. For the Indian Ocean region, there is a collaborative mechanism in Indian Ocean Naval Symposium (IONS), which addresses shared maritime security challenges and threats.

In addition, Maldives, signed a tripartite maritime security pact with India and Sri Lanka with a view of enhancing Maritime Domain Awareness (MDA) through Exclusive Economic Zone (EEZ) surveillance, training, and capacity building initiatives in areas of MDA, Search and Rescue, and Oil Pollution Response; and joint activities including trilateral exercises, maintaining lines of communication on illegal maritime activities, formulation of marine oil pollution response contingency plans, and cooperation in legal and policy issues related to piracy.

The way forward for maritime security is these collaborative mechanisms as the borders are porous when it is right next to international waters where merchant shipping vessels have right of way.

### **C. Ideological Dilemmas Facing the Muslim World and Maldives in Particular**

The Muslim world in general and Maldives in particular are facing Ideological dilemmas. In this era of Islamic revivalism, the Muslim Brotherhood, the forerunner of Sunni revivalism and the Shiite Islamism tended towards ideological convergence and collaboration. This can be seen from an article by the Muslim Brotherhood (Judeoscope, 2006):

Many commentators in the West still believe in the fairy tale that Sunni and Shia Islamists are at odds. Though most Sunni jihadis tend to see Shias as heretics and Hezbollah as a Zionist tool (go figure), the Muslim Brotherhood, by far the most popular of the Middle East's radical Islamists, and the Shia Islamists' history of mutual influence and collaboration traces back to the first Islamic revivalists of the 19th century and the political thought of the Brotherhood's own founder.

Throughout the twentieth century, Shiite and Sunni Islam had a very complex relationship with one another. The leading Shiite state of Iran (the cultural and theological

centre of Shiite Islam) and the leading Sunni State of Egypt, (the cultural and theological centre of Sunni Islam) were the centres of Islamic revivalism. However, both movements have the same goal and ideals of a Pan-Islamist Unity. It is this concept of pan Islamic unity that is the driving force behind all streams of Islamist revivalism. It is also the main political tool that is used in the mobilization of a diverse people from all corners of the Muslim world in the service of a common political agenda. Both Sunni and Shiite Islamists often claim that the resistance against west requires that Muslims put aside their differences and this is the rhetoric used by Iran, Hamas, Hezbollah, ISIS, and Al Qaeda.

#### **1) Extremism vs. Liberalism:**

The Maldives has a strong history of its liberal views on religion. However, the youth of today is facing a dilemma in regards to ideology. There is a strong polarization of extremism vs. liberalism occurring throughout the Maldives. The increased movement of Maldivian Foreign Terrorist Fighters travelling to Syria, the added exposure of hard lined clerics in the media, and the extremist views on dress codes, cultural etiquette like shaking hands, and vaccination are grave concerns, to name a few. Maldives need to propagate a comprehensive counter narrative to the extremist narrative if we want to remain the moderate Muslim Nation that we have been throughout history and to remain as the West's version of "Paradise on Earth."

#### **2) Rise of Islamophobia and its Implications:**

Anti-Muslim sentiment has been on the rise in Western Europe and the United States following the increasing terrorist attacks by Islamist terrorist organizations. Recently, the degree of Islamophobia has been revealed on multiple occasions. For example, debates about the construction of an Islamic center near Ground Zero in New York City and mosque controversies in a dozen states in the United States; anti-veiling legislation in France; the 'minaret' row in Switzerland; and the killing of Turkish immigrants in Germany are some of the well-known examples. Reports prepared by the European Center for Monitoring of Racism and Xenophobia (EUMC) in Europe (EUMC, 2006) and by Council on American-Islamic Relations (CAIR, 2006) in the United States also pointed to the rise of Islamophobia. Furthermore, recent polls found that Western citizens have strong negative feelings about Islam and Muslims (Esposito & Mogahed, 2007).

In 1997, in its much cited report, "Islamophobia: A Challenge for us All", the Runnymede Trust described

Islamophobia as “unfounded hostility towards Islam.” It refers also to the practical consequences of such hostility in unfair discrimination against Muslim individuals and communities, and to the exclusion of Muslims from mainstream political and social affairs. By and large, the Runnymede report has provided the most comprehensive definition of Islamophobia.

This definition includes such themes as otherness, inferiority, and fear of Islam and the perception of Islam as an aggressive and violent religion prone to terrorism. Western citizens view Muslims as fanatical, violent, and supportive of terrorism because they perceive them to be threatening to their physical well-being and cultural values.

In recent clashes between Islam and Islamic civilizations and that of others, there has been a misconstrued understanding of the religion and its teachings. Islam is a religion that respects all religions, their Prophets, and holy books. Just as the any acts of terrorism cannot subject an entire people, society, or nation, it must be noted that isolated acts of terrorism by extremists cannot be blamed upon a population of 1.3 billion Muslims dispersed around the world.

Majority of the western media has widely depicted Islam with these negative characteristics to fuel the “phobia” side of this perception. A lot needs to be done to change this misperception.

The media should emphasize the universal message of Islam; and by doing so, they can be a medium through which conflicts can be resolved. Media’s influence and role is that of a universal guardian; an institution that formulates religious, cultural, social, and political values. Its role must be played in a positive direction; one of unity and the advocator of the Oneness of all religions and faiths and increase the knowledge of Islam explained correctly. An informed citizenry may be less inclined to perceive a threat from all Muslims and hence may be the cure to the unfounded hostility and fear of Islam in the West.

### **3) Rise of Foreign Terrorist Fighters and the Success and Challenges in stopping their Movement:**

What is ravaging the Middle East right now is obviously deeper than ISIS. It has become commonplace over the last year to observe that we are witnessing the collapse of the post-Ottoman order. Sykes-Picot lines drawn in the deserts are being blown to dust. Though ISIS has religious, psychological, and technological faces, in most

fundamental respects it is an anti-colonial movement that takes as its reference point Islam’s pre-colonial Sunni caliphate. Even if ISIS is crushed, this idea of “Caliphate” is likely to persist and return.

As far as Maldives is concerned, there is a fragmentation of religious consciousness in today’s youth. Contrast this with the observation by anthropologist Clarence Maloney in the 1970s: Islam in the Maldives was limited to washing, fasting and praying. What he meant was that Islam was largely a practice and there were no theological arguments at all. However, Islam has by now become the contest of vigorous disagreements. Islam is an object of vigorous talks, disputes, and theorisation.

There are a number of Maldivian youths joining the Al Qaeda’s Jabhat al-Nusra in Syria. For the youth travelling to Syria, the Maldives is under jahiliyya (religious darkness) and is ruled under a taghut (idolatrous system). Maldivians, they believe, should undertake hijra (migration to a pious land) and perform jihad (wage a holy war) against the non-believers.

The majority of Maldivian Foreign Terrorist Fighters have joined al-Nusra. The accusation that Maldivians are joining ISIS may not be factually correct as al -Nusra is not in agreement with ISIS and its ideology of an Islamic State in the current mode. Maldivian fighters who are with al-Nusra continue to portray ISIS as a deviant group.

However, it is irrelevant as to which group, the Foreign Terrorist Fighters belong. The government of Maldives is earnestly working to stem the foreign fighter flow from the Maldives and have been successful in stopping the jihadis from travelling to Syria. This has resulted in an increase in the number of youths with violent extremist ideologies who are frustrated because they were unable to fulfil their dreams of mansions in paradise. The government of Maldives needs to conduct very comprehensive deradicalisation and counter-radicalization programs to rehabilitate these youth back into the mainstream of Maldivian population.

## **D. Economic Security and its Impact on National Security – Maldives Story**

### **1) Rise of Tourism:**

Maldives was traditionally a sea faring people. Their livelihood depended on fisheries and merchant shipping. The industry that transformed the face of Maldives started in 1972 with the opening of Kurumba Village with thirty

guest rooms. Then nobody would have thought that a bunch of small islands scattered in the Indian Ocean is set to be one of the world's top tourist destinations today. However, today Maldives is on the front pages of most of the magazines of the tourism and travel industry and is considered to be the world's most prestigious destination.

## 2) Need for Diversification into other Industries:

Both the fishing industry and the tourism industry are seasonal and fickle industries. Especially the tourism industry on which the whole Maldivian economy is dependent could be devastated by a natural or environmental disaster, a pandemic or terrorist incident, a travel ban or a Wall Street crash to name a few. This has led to the need for diversification of the economy. The lagoons of Maldives are natural habitats that could be economically viable for aquaculture. The hundreds of islands that are uninhabited could be used for the manufacturing industry, as there is an abundance of renewable energy such as solar, wave and geothermal energy available in Maldives and a network of airports throughout the nation for transport of goods.

## 3) Use of Maldives' Strategic Location:

Today Maldives is set to utilize its strategic location straddling the main sea lines of communication in the Indian Ocean to its economic advantage. The "iHavan" project next to the 8-degree channel where most of the Indian Ocean merchant ships travel is set to transform the Maldivian economy by an order of magnitude. The "iHavan" project is an integrated project designed for the northern most atolls of Maldives. The project capitalizes on the strategic location of the atolls straddling the 8-degree channel, which is the main East- West shipping route of the Indian Ocean.

The components of the project include investments in transshipment port facility, airport development, and a cruise hub, yacht marina, bunkering services, dockyard, real estate and conventional tourism developments. More than US\$ 18 trillion worth of goods are transported across the 8-degree channel annually, with over 70,000 ships crossing the Indian Ocean every year.

A transshipment port stands to benefit from the growing trade volumes passing through the 8-degree channel because of strong growth in India and China. iHavan's central location in the Indian Ocean will have easy access more than thirty large cities within a radius of 4000 km presenting immense opportunity for online trading businesses and mass warehousing for large scale retailers.

Furthermore, the unrivalled natural beauty of the island's geography in the region has huge potential for high-end real estate and tourism development (Ministry of Economic Development, 2014).

## 4) Energy and Food Security:

Maldives is a nation that is heavily dependent on the import of fossil fuel for nearly all its energy use and is highly susceptible to external shocks. The Maldivian government is concerned about environmental degradation, global warming, sea level rise, and emission of greenhouse gases (GHG) and pursuing policy of using renewable energy wherever it is feasible. The use of solar energy is already on the rise in the electricity generation of the Maldives.

Maldives' 2015 energy balance shows that there was approximately 500 kilo tonnes of oil equivalent of energy consumed in the Maldives of which over 80% was from imported diesel oil. Energy consumption contributes to about 1.7 million tonnes of carbon dioxide emissions in 2016, which is about 0.003% of global emissions. Energy consumption in various sectors constitutes a major share of the country's GHG emissions. Maldives intends to take actions and undertakings to reduce unconditionally 10% of its GHG emissions by the year 2030 by incorporating extensive use of solar power.

Food security in Maldives is unique as the country depends on imports for most of its food needs. Fishing and subsistence agriculture are the main sources of food security and livelihoods for a vast majority of the people. Climate change is central to all discussions about food security in Maldives, because it is adversely affecting crops and fish stocks and reducing land area and the fresh water lenses of the islands as the sea level rises. Developing agriculture as the third pillar of the economy, after tourism and fishing, is one of the priorities of the National Development Plan of the Maldives.

## E. Human Security from the Perspective of Maldives

### 1) Disaster Resilient Communities:

Maldives, due to its low lying nature and the flat topography, regularly get affected by high frequent, low impact seasonal events such as monsoonal flooding, coastal erosion, salt water intrusion, and intense sea surges related flooding due to climate change and sea-level rise. Maldives is exposed in the open sea to Tsunamis that may develop in the active Sumatra fault. Therefore, the eastern sectors of the northern and central islands are highly exposed to tsunamis generated in the Indonesia Region.

The northern islands have the greatest exposure to surge hazards and cyclones. Maldives experience thunderstorms, flash floods, and water shortage during the dry North east Monsoon.

Disaster resilience is the ability of individuals, communities, organisations, and states to adapt to and recover from hazards, shocks or stresses without compromising long-term prospects for development. The National Disaster Management Centre (NDMC) of Maldives is entrusted the mission to “save lives and protect livelihood” and are given a set of mandates (National Disaster Management Centre, 2016) to make Maldives a more disaster resilient nation. Their mandates include both natural disasters (tsunamis, sea surges, floods, heavy rainfalls etc.) and man-made disasters (fires, water shortages, oil spills etc.). NDMC has initiated successful awareness programs and, in collaboration with UNDP, initiated disaster risk reduction and management programs and with UNICEF, have initiated the Low Emission Climate Resilient Development (LECReD) Programme.

## 2) Gender Equality:

Empowering women and promoting gender equality is crucial to accelerating sustainable development. Ending all forms of discrimination against women and girls is not only a basic human right, but it also has a multiplier effect across all other development areas. Gender equality is one of 17 Global Goals that make up the 2030 Agenda for Sustainable Development (UNDP, 2012).

This year, 55 percent of students passing out of high school in 2015 were girls. In August of 2016, the Maldivian Parliament approved the Gender Equality Act. The law that sets out the role of government, political parties, and businesses in bridging gender gaps in political, economic, and family life. The Gender Equality Act requires employers to provide equal opportunities and equal pay for men and women, set up committees to investigate complaints of discrimination, and take measures to eliminate obstacles to women’s participation in the labour force.

Clearly, the success of women directly reflects the success of a society as a whole. Of all the criticisms leveled at Muslim countries by far, the most common is the position of women in society. Some have dismissed Islam as an inherently misogynistic religion that has no tolerance for gender equality, exacerbated by the false narrative perpetrated over decades that Muslims hold values that are incompatible with other nations or cultures. Men and women were described in The Quran as equal members of

society. The movement towards true gender parity within the Muslim world will require efforts across generations and political divides. It will continue to rely on the bravery of women to challenge discrimination as well as on the support of men. Maldives is a shining example of gender equality to the Muslim World.

## 3) Climate Change and Sea-Level Rise:

The Maldives believes that climate change is the twenty-first century’s greatest development and security challenge. Climate change threatens the integrity of Earth’s climate system and ecosystems. Negative effects are already taking place and these will gravely undermine our efforts towards sustainable development and threaten our very survival and the sovereignty of our nation. We have a right to pursue all means to ensure that our nation survives, and our legacy remains in these islands. We have an obligation to hand these beautiful islands over to the future generations.

According to the Intergovernmental Panel on Climate Change (IPCC), Small Island Developing States (SIDS) like the Maldives are the ones who will be hit first and hardest by global climate change. SIDS have not only contributed the least to climate change, they are also among the least equipped to respond and adapt to the effects of climate change. Additionally, these islands are in a special risk of being inundated as sea level rise. Land loss and beach erosion continues to increase and threatens food and water security. However, SIDS cannot do this alone; regional and global cooperation is imperative to put Small Island Developing States like Maldives on a pathway to build a climate resilient economy in order to mitigate and adapt to climate change. Therefore, international cooperation is essential to fight against climate change. Any failure to reach an agreement to radically cut emissions would jeopardize our development and survivability. Recognizing this, the international community is actively engaged in minimizing the current effects and likely future adverse impacts through effective implementation of the provisions of the United Nations Framework Convention on Climate Change (UNFCCC).

Within the context of extreme vulnerability to climate change impacts and to address these impacts, the Maldives has developed a National Climate Change Policy Framework, to provide a blueprint to build resilience in partnership with our regional and global partners. In this context, the Maldives Climate Change Policy Framework (MCCPF) prescribes the government and the people of Maldives strategic policies for responding to climate

change impacts over the next 10 years (2014–2024). The policy defines five thematic goals and strategies that the government and the people of Maldives have prioritized for implementation to ensure that safety and resilience are achieved.

## IV. CONCLUSION

The post 9/11 security scenario is that the threat spectrum has shifted predominantly towards asymmetrical threats from non-state actors. For nations with International borders in the sea, the threat is going to emanate from the sea and there is need to have international and regional mechanisms to address the complex issues of maritime security. Being a 100% Muslim country, we are not immune from ideological dilemmas facing the Muslim world and need to formulate a national framework to address the issue of violent extremism and radicalization. The issue of climatic change threatens the very existence of low-lying nations like Maldives and we need to convince the international community to reduce the emission of Green House Gases to ensure the survivability of Small Island Developing States like Maldives.

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# CHANGING DYNAMICS IN THE MARITIME DOMAIN: SPECIAL EMPHASIS ON THE INDIAN OCEAN

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Aayubowan! Subha Udesanak Wewa! It is really great to be back in Sri Lanka and to have a chance to attend the 10th International Research Conference (IRC). I spoke at the 8th IRC and it was a wonderful experience. I found it to be an important forum and great learning experience where ideas were freely expressed and exchanged. And I also enjoyed the cultural tour to Kandy. It was the time of the Pera Hera. Sri Lanka has such a rich culture and vibrant history. I was asked to talk about the changing dynamics in the maritime domain with a special emphasis on the Indian Ocean. This is such a rich topic. I am a big fan of Robert Kaplan and his masterpiece of a book, *Monsoon*, which focuses on the Indian Ocean and how global power is shifting in the twenty-first century. *Monsoon* had a big influence on me when I read it back in 2010 and when we were writing the U.S. Navy strategy in 2014, we decided to use the term Indo-Asia-Pacific rather than what was then the more accepted term, Asia-Pacific. We used this lexicon because: --we recognized the reintegration process that was underway among East Asia, Central Asia, South Asia, East Africa, and the Middle East --widening the aperture to the expanded scope of the Indo-Asia-Pacific countered any negative perceptions that we were shifting our focus away from Southwest Asia in favor of East Asia. -- I personally felt that this allowed us to view China in the larger context of Asia rather than overly focusing on what was going on in the South and East China Seas.

The Indo-Asia-Pacific remains the most dynamic region in the world. The center of gravity for economic activity and trade has shifted east of Suez. I was reading in Parag

Khanna's excellent book, *Connectography*, that in the 1970's, transatlantic trade represented 80 percent of global trade.; by 2013 it was only 40 percent. The trade nexus between East Asia, South Asia, Africa, and the Middle East now makes up a significant portion of world trade. Accordingly, the Sea Lines of Communication (SLOCs) that run across the Pacific and Indian Oceans are the economic lifeline of the world. Globalization rests on the free flow of international maritime trade. Ninety percent of world trade by volume travels across the oceans and about 70 percent of the world's population lives within 100 miles of the coastline. Plus, the sheer vastness of the Indian and Pacific Oceans point to the need for all of us to work together be it for MARITIME SECURITY, ECONOMIC SECURITY, or HUMAN SECURITY. It is just too big a job for any one country or navy.

No country is too big that they can't use help, and no country is too small that they can't make a valuable contribution. We also must collectively ensure that this vital region remains open and inclusive, while respecting established rules and norms in the maritime domain. So when I was asked to talk about some of the changing dynamics in the maritime domain, I focused on three areas. 1) Traditional and non-traditional maritime security threats are increasing 2) Evolving Military Challenges to include anti-access in the Indo-Asia-Pacific 3) New Silk Roads and Infrastructure Provision in the Indian Ocean Region Let's look at the maritime security challenges first. To give you some idea of the scope of the problem, and just how big this ocean area is. It is over



8,000 nautical miles from Shanghai to the Gulf of Suez. From the Gulf Of Suez to Colombo, Sri Lanka it is 3,695 nautical miles. If you look at slide #5 you will also see that this same ocean area comprises some of the most strategic maritime passages (or navigational choke points) in the world. These include the Strait of Malacca, the Strait of Hormuz, Bab-el-Mandeb, Sunda, and Lombok. If you look at the same map of the Indian Ocean that displays shipping route density, you would see how much shipping traffic converges at these strategic passages and what a disruption to the flow of these merchant ships would cause to the global economy. With the globalization phenomenon and the need of these large Asian economies for imported energy one can imagine that this trend will only continue. This is also the region that in terms of natural disasters is probably the most dangerous in the world.

We are all familiar with the 2004 Indian Ocean Tsunami, Cyclone Nargis in 2008, the Tsunami and nuclear crisis in Japan in 2011, Typhoon Haiyan in the Philippines in 2013, and more closer to home, Cyclone Mora which just a few months ago caused devastating floods and landslides, tragic loss of life and the displacement of over 400,000 of the Sri Lankan people. Sadly, these extreme weather events will only become more frequent in the future. Is it now time to set up some coalition or mechanism to more quickly respond to these events across the region? I think this is a conversation we need to have. These are seasonal events, and could have a seasonal ready response force. In terms of maritime security, we also have to remember that this is the region that saw the Mumbai terror attack of "26/11". (Which came via the sea from a commandeered fishing vessel.) As well as the Tamil Tigers who used seaborne terrorism as a tactic against Sri Lanka. This region continues to deal with the risk of piracy and armed attacks at sea. While incidents of piracy are down off the east coast of Africa, armed attacks have actually risen in the Bay of Bengal and Malacca. To be sure, there has been a lot of good progress in this region with the formation of organizations like Regional Cooperation Agreement on Combating Armed Robbery and Piracy (ReCAAP) and the standing up of The Information Fusion Centre (IFC) in Singapore. These are great examples of the region working together to solve hard problems.

We also have the issue of Illegal Unreported and Unregulated (IUU) fishing which becomes a matter of both livelihood and security. And with overfishing, pollution and mismanagement of ocean resources this could become a major issue of food security in the future.

I haven't even addressed migrant and refugee issues which we will also have to deal with, but you see how complicated an overlay of maritime security concerns could become. For all these reasons, it is so important that we work together in these interagency and multilateral fora to promote peace and prosperity. The second area I'd like to talk about in respect to the changing dynamics in the maritime domain are the evolving naval and military challenges. There is a strong push for naval modernization among the countries of the Indo-Asia-Pacific. I see three drivers of naval modernization in the region to be

- 1) competing/potentially conflicting maritime interests (e.g. access to resources)
- 2) as a response to modernization/ expansion by potential competitors, or
- 3) in response to specific security challenges So essentially, there is a maritime arms-race ongoing in the Indo Asia-Pacific.

Some countries are focused on anti-access weapons and strategies. This is a serious problem as access is a pre-condition for monitoring the health and safety of the maritime domain, for ensuring freedom of navigation, and for building and sustaining relationships of the countries sharing the global maritime commons. The other concerning trend that I see is the proliferation of submarines in the region. All the major countries in the region are increasing or modernizing their submarine capacity. Additionally, new countries are seeking to enter the submarine game. These include Malaysia and Thailand as well as Singapore.

One way to think about the naval modernization that is taking place in the region is in terms of stabilizing vs destabilizing capability development. I see many capabilities such as MDA, environmental monitoring and law enforcement, maritime C2, coastal patrol and HADR capabilities as generally stabilizing. Conversely, there are other capabilities that are much more potentially destabilizing. All of this has implications for what capabilities countries should pursue. Remember our ultimate goal should be to protect the global commons, respect the rule of law, preserve the peace and to respect individual nations' sovereignty. The third phenomenon that I see in this region in terms of the maritime domain and the Indian Ocean rimland is that of the accelerating competition in terms of physical connectivity in connecting Asia. By this I am referring to port infrastructure, new road and rail networks, and economic and security infrastructure provision across

the region. Physical connectivity and infrastructure are manifestations of overall economic development – which can be collaborative or competitive (or both at the same time). This infrastructure play that is occurring in the Indian Ocean Region could have significant strategic consequences. Infrastructure investment, economic development, and increased connectivity are generally good for everyone. However, economic growth combined with population growth and rising expectations increase the potential for competition for resources, for markets, and for regional influence. This has the potential to lead to actual confrontation. This is actually an exciting time to watch as the Silk Roads and Spice Routes are returning. China's planned Belt and Road Initiative (BRI), which seeks to link, through infrastructure provision, economies across Eurasia and East Africa is the perfect example of this. New supply chains are being created, and the question is whether they will be inclusive or exclusive and what cost participants will be asked to pay (e.g. influence). Now, please let me shift gears for a moment and talk about all the positive developments over the last couple of years in our military to military relationship. U.S. - Sri Lanka relations are currently at an all-time high. I was really

excited to see the visit of the USS BLUE RIDGE, the U.S. Seventh Fleet's Command Ship, to Colombo in March of 2016 where the ship hosted Sri Lanka President Sirisena. This paved the way for three more high profile port calls by U.S Navy ships last year. This included the visit of the USS SOMERSET and her embarked marines where they conducted an important theater security exchange with the Sri Lankan Navy and Marine Corps that concentrated on humanitarian assistance and disaster relief missions. Also last year, for the first time, Sri Lanka sent two officers to participate in the RIMPAC 2016 exercise as observers. This is the world's largest maritime exercise and I am sure that the Sri Lankan officers gained much from the experience that they can share with their fellow Sri Lankan military officers. Additionally, last year marked the restoration of IMET, which can only further deepen ties between our two militaries in the future. These are just a few of the examples of how far we have come in just a short while in terms of this vitally important strategic partnership. This is a long-term commitment and we look forward to the future and what will become many significant security contributions to the Indian Ocean Region from Sri Lanka.

# THE ESTABLISHMENT OF DEFENCE SCIENCE AND TECHNOLOGY IN SRI LANKA

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**Abstract** - It is well understood that for a modern military to be effective it needs to have access to an advanced science and technology organisation specialising in defence related activities. This includes both project based and long-term research. The balance for defence applications between the funding of project based research, and funding for long term defence research is discussed.

Many countries conduct all defence related science and technology activities within government, whereas others outsource much of this activity to the commercial sector, including universities.

Some technologies which are used by the military are advancing rapidly in the civilian sector. For many of these technologies the civilian sector can generally apply larger resources to such developments than is available from military funding. For those it may well be more appropriate for defence to maintain a watching brief on such activities, rather than to attempt to conduct its own research in these fields. This is of particular importance if the resources available to defence research activities are limited.

Other technologies are specific to military applications, or involve sensitive information, and for these it is usually necessary that the science and technology research is conducted with the specific defence applications in mind. Although such research needs to be funded, and guided, by the requirements of the military, it is not always essential that it be conducted internally in a defence laboratory. Provided adequate security can be assured, such research can be carried out by organisations external to the military, including commercial companies and universities.

Even where a particular technology is for a military application there are often considerable synergies with non-defence science and technology. These could be either software (people and know-how) or hardware (facilities and equipment) where in many cases the same expertise and facilities can be used for both military and civilian applications and it is recommended that this be applied wherever possible in the development of defence science and technology research in Sri Lanka.

Thus, two important aspects in the development of the defence science and technology capability in Sri Lanka are:

- The ability to determine what technologies are best handled in the civilian sector, and the maintenance of a watching brief on these; and
- When defence specific research is required, to determine where synergies are available, and how they can best be managed.

These aspects could well be handled by a defence orientated university such as KDU and suggestions as to how that might be done are given. Also, the benefits of much of the longer-term research being conducted by a university such as KDU are discussed.

## 1. INTRODUCTION

It is well understood that for a modern military to be effective it needs to have access to an advanced science and technology organisation specialising in defence related activities. This has always been important in the history of warfare, but is becoming even more so nowadays as the pace of technological advances increases, and the military makes ever greater use of advanced equipment, rather than relying on large numbers of soldiers.

A country that uses out of date military equipment will be at a major disadvantage in any conflict. The soldiers deserve to have access to state-of-the-art equipment, and if this is not provided then their lives will be at unnecessary risk, and the country is likely to lose any conflict that it is involved in.

A strong understanding of the latest developments in defence related Science & Technology (S & T) is essential to enable a country to:

- a) be a smart buyer of military equipment, both from within the country and overseas;
- b) understand the state-of-the-art in military equipment relevant to its needs, and hence determine what is and is not required for its defence needs;
- c) update, maintain, and make best use of existing equipment;
- d) train defence personnel in the best use of the equipment;
- e) encourage developments nationally that improve its military equipment; and
- f) be in a good position to liaise with similar defence related S & T organisations in other countries.

Thus, it is important to have a strong national capability in defence related S & T. Although it will require a significant resource to do this, the alternative will be very costly, both in terms of poor acquisition and maintenance of equipment, and in the much more important consequences of having an inferior defence force.

## 2. RESEARCH LEVELS AND FUNDING SOURCES

Military S & T can range from that required for short term project based applications to the longer term research needed for more fundamental studies.

### 2.1 Emphasis on short term project based activities

There is a view that all defence research work funded by a government ought to be directly applied to future acquisition projects, and that money spent on longer term research is wasted. Those who subscribe to this view believe that it is the acquisition process which should drive the priorities, and that all funding going to defence

research should be channelled through project teams that will be the direct beneficiaries of the research – ie current projects and those already in the acquisition pipeline.

It could be argued that this philosophy is what drove the policy in the UK in the 2000s, where the various autonomous defence research agencies were amalgamated into one larger one, which then became a Trading Fund, before eventually being privatised, and finally floated on the stock market. One result of this has been that all the research being conducted is done so at the express request of the UK MoD, who supply all the funding for every project. Much of this comes directly, or is at least strongly influenced, from project teams who are looking for answers to problems today.

Another result was that those acquiring research are not required to go to a single organisation, but are free to select from many competing companies. Whilst in the short term this appears to have many attractions, including the usual issues associated with increased efficiency caused by competition, it does mean that long term defence corporate knowledge becomes fragmented, and there is a danger that the UK's defence research capability is weakened as a result.

In addition, as the various research providers don't necessarily have long term contracts they are reluctant to invest in the necessary infrastructure, such as ranges, or large pieces of experimental kit. This was overcome (eventually) in the UK by establishing long term contracts for such activities, with key performance indicators.

A final result of this policy was that each of these competing companies has its own interests uppermost, rather than the long term interests of the UK Defence. An attempt was made to solve this problem by retaining many of the senior scientists in a Government owned organisation – the Defence Science and Technology Laboratory (Dstl).

### 2.2 Need for longer term research activities

In addition to the short term project support required by defence, there is also the need to conduct longer term research activities without the need for specific applications. This includes the so called “blue sky” research, which is essential to any major breakthroughs.

Longer term research is needed to understand the fundamental principles and background knowledge which is required to better utilise existing technologies. If only project based short term activities are being undertaken

then it is likely that today's problems will be solved sufficiently well to "get by", but that longer term solutions will not be addressed.

Finally, longer term research is also important to maintaining the capability in a research organisation, such that it is well placed to conduct the short-term activities to support project based activities. This is a particularly important aspect for fields which are specific to defence applications. If the magnitude of the project based work reduces, for whatever reason, there is the danger that scientists working in these fields will be laid off, and the capability to service these fields will wither. If that occurs, and defence subsequently has a requirement for project based activities in these fields, then it will not be available. Such short sightedness, whilst appearing to save money in the short term, could easily lead to serious consequences for defence in due course – once it is too late. The rebuilding of a defence research capability in a field which has been allowed to be closed, can be very expensive and time consuming.

One of the difficulties with longer term research is in determining what the priorities should be.

On one hand, project managers in defence, who are well acquainted with the current in service issues, and the proposed acquisition strategy, may feel that they should be able to dictate the priorities to the scientists. However, there is the danger with this that these project managers may not be able to see "the big picture" and may be overly influenced by today's problems. They are likely to have Key Performance Indicators based on expenditure today on their projects, and are unlikely to have separate funds for longer term work, not directly related to their current projects.

On the other hand, if the scientists are left free to decide their own priorities then there is the danger that their "hobbies" will be pursued with little regard for real defence requirements. Of course, it is well known that most substantial breakthroughs, and game changing science, comes from the "blue sky" research associated with scientists pursuing their own fields with little regard for application. However, clearly defence research scientists need to be guided to work in areas of current, or future, benefit to defence. Although, within a large defence research organisation a small resource could perhaps

be allocated to science-push applications, driven by the scientists, this may be a luxury that many defence research organisations can't afford.

Thus, a mechanism for determining the priorities for longer term activities needs to be developed which is a balance between:

- a) long term research to support in-service and proposed acquisitions;
- b) the gaining of fundamental understanding where relevant;
- c) a small proportion of "blue sky" research driven by scientists; and
- d) the need to maintain capability in defence research where project based work is not sufficient to maintain this.

### 2.3 Interaction between different levels of S & T activities

There can be a good interaction between the two levels of S & T activities, as shown in figure 2.1.

On the right hand side of the figure the interaction between the individual projects requirements and the advice being provided is shown. As can be seen, the projects place the requirements for the project based advice (and may have to pay for this). The outcomes are then provided directly to these projects, along the lines of consulting activities.

The left hand side of the figure shows the longer term research activity. As can be seen here, the projects can advise on requirements for long term research activities, although, as noted above, this should not be the exclusive way of determining what long term activities are required.

The long term activities are also used to maintain capabilities, which ensure that there is the capability to provide project based advice. The conduct of that project based advice also gives feedback into the long term research.

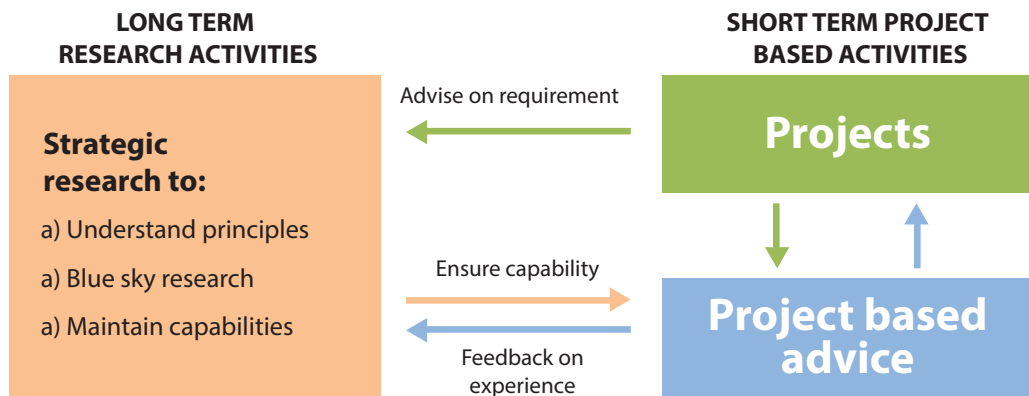


Figure 2.1 Interaction between research levels

### 3. WHO SHOULD CONDUCT MILITARY S & T

Many countries conduct all defence related S & T activities within government, whereas others outsource much of this activity to the commercial sector, including universities.

Many technologies are specific to military applications, or involve sensitive information, and for these it is usually necessary that the science and technology research is conducted with the specific defence applications in mind. Although such research needs to be funded, and guided, by the requirements of the military, it is not always essential that it be conducted internally in a defence laboratory. Provided adequate security can be assured, such research can be carried out by organisations external to the military, including commercial companies and universities.

As noted above, the major UK defence government laboratory, DERA, was privatised in 2001, and subsequently became a publicly listed company, QinetiQ. The UK MoD retained very little ability to conduct research itself, other than for a small range of very sensitive technologies. Initially QinetiQ was guaranteed most of the UK MoD research work, but this was gradually tapered down. Currently, QinetiQ bids for research contacts alongside other commercial companies. Not being constrained by the public service terms and conditions has made it possible for QinetiQ to be more flexible in the way it operates, which in many cases has been an advantage. On the other hand, QinetiQ has shareholders, so the primary

responsibility of the company is to these shareholders, and to ensure an adequate profit, rather than to serve the nation's national defence needs.

The need to conduct longer term defence related S & T is discussed above. In many areas it is probably very appropriate that these be conducted by universities. In general, universities are good at long term research, particularly when publication of the results is permitted. Also, defence can often get very good value for money by contracting universities to conduct long term research in fields of interest to military applications. The defence S & T organisations in countries have long term standing arrangements with particular universities for this purpose. This allows for the construction of specialist facilities within the university, and the development of research groups. A further advantage of defence sponsored research at universities is that the universities will provide a ready source of staff for the defence S & T organisation – both at PhD and graduate level. For example, the US defence has had long term partnerships with universities such as Penn State University, and Virginia Tech.

### 4. CIVILIAN VERSUS MILITARY S & T

Some technologies which are used by the military are advancing rapidly in the civilian sector. For many of these technologies the civilian sector can generally apply larger resources to such developments than is available from military funding.

A good example of this is battery technology. The commercial sector is making considerable developments in battery technology, and has an extremely large number of customers for advanced batteries. Thus, it can apply major resources to research activities associated with improving battery technology, and hence there is little point in any defence organisation doing much in this field.

For such technologies it may well be more appropriate for defence to maintain a watching brief on such activities, rather than to attempt to conduct its own research in these fields. This is of particular importance if the resources available to defence research activities are limited. This watching brief could be carried out directly by defence, or contracted to a third party.

Other technologies, such as those required for the safe operation of submarines for example, may not be being addressed by the commercial sector. These are fields where the relevant S & T will need to be funded by defence. However, even in these cases it is not essential that the S & T work actually be carried out by defence, provided adequate procedures are in place to ensure the long term continuity of the work, and to safeguard adequate security.

## 5. SYNERGIES BETWEEN MILITARY AND CIVILIAN S & T

Even where a particular technology is for a military application there are often considerable synergies with non-defence science and technology. These could be either software (people and know-how) or hardware (facilities and equipment) where in many cases the same expertise and facilities can be used for both military and civilian applications.

A good example of this is the need to be able to assess the structural integrity of naval warships. This is clearly of great importance to defence, and in the past many nations dedicated large teams to this task. However, the expertise required is similar to that required to assess the structural integrity of merchant ships. Thus, it has now been fairly common to make use of civilian naval architects who also do such work for commercial vessels. In many cases these are employed by one or other of the classification societies which have extensive programs of research into the structural integrity of ships. As a result, defence has benefited from the latest research into structural integrity of ships being carried out in the commercial sector.

In terms of the dual use of hardware, in order to predict the performance of military vessels it is necessary to make use of hydrodynamics testing facilities. However, they can also be used to predict the performance of commercial craft. Thus, unless the facility usage is so great that it can be dedicated to defence activities, it can be shared with any commercial projects. Most nations operate only one large hydrodynamics facility, and make arrangements for the use to be shared between defence and commercial projects.

In addition, universities involved in teaching subjects such as naval architecture, and those doing research in this field, also require access to hydrodynamics facilities, and in some cases they also use the same ones.

Hence, defence may not need to cover the whole cost of acquiring and running such large expensive facilities, but this can be shared with the commercial sector – provided adequate security is guaranteed when it is being used for defence purposes.

## 6. PARTNERSHIPS

Of course many national defence S & T organisations can't hope to cover all aspects of defence S & T themselves. As noted above, one way of doing this is to outsource some of the work to the commercial sector and/or universities.

However, an additional approach is to partner with the defence S & T organisations in like-minded nations. This also has the advantage of sharing resources, as each nation will pay for its own activities. To engage in this process it is necessary to have something to provide to the partnership. Nations will not want to team up with countries which are not able to offer something to the partnership. Ideally, each nation should be able to provide a strength in a slightly different area, and so all those involved will benefit.

In addition, benchmarking exercises, possibly using unclassified test cases, can be conducted which are very valuable ways of ensuring that the S & T organisation is operating at the state-of-the-art. This is frequently not possible in the public domain, as the problems being addressed by defence S & T organisations are often different to those being undertaken by commercial organisations. For example, it would be difficult to find somebody to benchmark predictions of submarine performance with in the commercial domain.

Partnerships with overseas defence S & T organisations could be carried out directly by a government defence establishment, or be subcontracted by defence to a commercial organisation, or even a university. Of course, if the partnership is subcontracted it will be important for defence to retain control of this, and in many cases the overseas defence organisation will want to involve the national defence organisation in any such partnership arrangements.

- a) Create a new defence S & T establishment within government which conducts all defence S & T for Sri Lanka;
- b) Outsource all defence S & T activities to the private sector in Sri Lanka;
- c) Make use of the existing General Sir John Kotelawala Defence University as the prime defence S & T organisation in Sri Lanka.

## 7. OPTIONS FOR ESTABLISHMENT OF DEFENCE S & T IN SRI LANKA

### 7.1 General

As noted above, defence S & T can be done on a project by project basis, and/or on a longer term research approach.

There is also the need to determine what areas need to be specifically addressed by defence, and which fields are better left to the commercial sector, with defence only conducting a watching brief on progress.

Defence S & T can be carried out by:

- a) a national defence organisation;
- b) one or more commercial companies; or
- c) one or more universities.

Many countries make use of a combination of the above three. In some cases the mix is for historical reasons, with government laboratories having been established many years ago. The UK has attempted to break this mould, with the privatisation of its government research agency, and now places much more emphasis on the commercial sector to conduct its defence S & T activities.

In many ways Sri Lanka is fortunate in not having an existing major defence based S & T establishment. This means that the development of a capability in defence S & T can start with a relatively “clean sheet”.

On the other hand, it is assumed that Sri Lanka does not have sufficient resources to establish a major government defence related S & T organisation. Thus, the following options are considered as possible ways to establish effective defence S & T activities in Sri Lanka:

### 7.2 A new defence S & T establishment within government

The creation of a new government defence S & T establishment in Sri Lanka would at first glance seem to be the best way of generating an appropriate level of defence S & T in the country.

This will ensure that the Sri Lankan Ministry of Defence (MoD) has complete control over the S & T being conducted, and it will be relatively easy to form partnerships with overseas defence S & T organisations. In addition, there are unlikely to be any issues with security, or with continuation of expertise in relevant defence related fields. There are also a lot of advantages in having one central repository of defence S & T knowledge.

However, this is certainly likely to be an expensive approach, both in terms of the initial creation of this organisation, and in the running costs. As noted above, there are a lot of synergies with commercial S & T activities, and the creation of a government defence S & T establishment may actually make it difficult to benefit from these.

Also, a new government establishment may turn out to be much less flexible than required – particularly as priorities within defence S & T change.

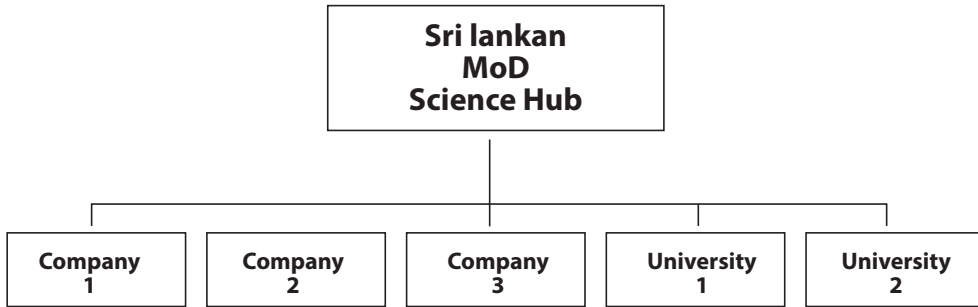
### 7.3 Outsourcing of all defence S & T activities to the private sector

It would be possible to outsource all defence S & T activities to the private sector, requiring the various commercial organisations (including universities) to bid for each research “package”.



To do this it will still be necessary to have a small hub of experts within the Sri Lankan MoD to determine what work needs to be done, to place contracts and to review

the work being done. This is shown schematically in figure 7.1.



*Figure 7.1 Possible outsourcing model*

With this model it is important to recognise that the companies' goals are to maximise profits, rather than to operate for the good of the country. Also, the motivations of the various universities may not be for the good of the country, but to benefit the individual academics and universities involved.

Dstl, when it was privatised to become QinetiQ. These staff were respected by the staff in QinetiQ (often they had been leading the research groups before the split) and so the process worked quite well. However, as these experienced staff retired it became difficult for Dstl to recruit adequate replacements with the same expertise.

On their own these are not necessarily bad things, but it does mean that the performance of the companies and universities will need to be monitored carefully by the scientists in the government S & T hub. To do this the government scientists will need to be experienced in the fields, and know what is achievable and what is not for a given budget. For research based S & T activities this is not particularly easy, as by the very nature of research things don't always turn out as expected. Because it will be important to be conducting cutting edge research it will be important that the work packages are challenging, and not always straightforward, but achievable.

In the case of Sri Lanka, where it is assumed that many of these experienced scientists don't currently work for the government this may be even more of a challenge.

When the UK privatised its defence S & T agency (DERA, which became QinetiQ) it retained a small number of scientists whose job it was to advise on the research packages and then to oversee the work being conducted by the various commercial companies. One of their tasks was to make a judgement as to whether the work being done by the commercial companies was at the appropriate level.

A further disadvantage of this model is the fragmentation of the research, and the lack of long term continuity. One company may start doing research in a field, but may lose the subsequent commercial bid for follow on work in this field. As a result many of the research packages placed were for a number of years, to attempt to retain continuity. This made the competition to win such a bid very strong, which on one hand could be seen to be of benefit, as the companies cut their prices, but on the other hand resulted in possible short cuts in the work being done. Also, the companies didn't always work together in a cooperative manner, with issues such as sharing of resources and information.

In some cases companies teamed together to bid for research work packages.

Initially this was done by retaining many of the senior scientific staff from DERA in a government organisation,

In this model, partnership with the defence S & T organisations in other countries may also be difficult.

Many countries want to deal only with government agencies, and hence the formal partner will need to be the government defence S & T hub.

However, as they won't actually be conducting the work themselves, but overseeing it, it will almost certainly be necessary for them to involve the appropriate commercial company, or university, in each particular partnership. This is the process often required by the UK MoD for such partnerships. Sometimes, for part of the meetings staff of the commercial company (often QinetiQ) are not able to be present – depending on the requirements from the other partners.

Of course, if the commercial company holding a particular contract changes, then this will mean that any such partnerships will need to change. Clearly this is not so attractive to other nations, who would prefer to establish long term links with the S & T activities in Sri Lanka.

**7.4 Make use of the existing General Sir John Kotelawala Defence University as the prime defence S & T organisation in Sri Lanka.**

An alternative approach for Sri Lanka could be to make use of the existing General Sir John Kotelawala Defence University (KDU). It is assumed that most, if not all, of those active in defence S & T in Sri Lanka are already working there. Also, being government employees they are presumably not motivated purely by profit in the same way that a commercial company is. Thus, they are more likely to focus on the long term benefit to the nation of the work that they are doing. Academics do generally tend

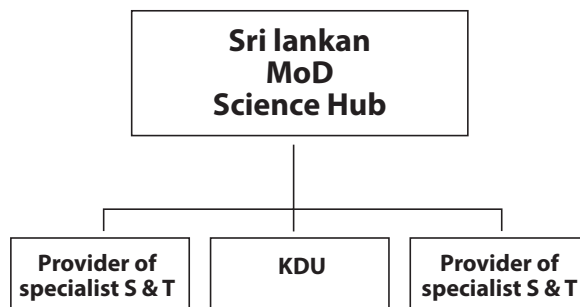
to have a longer term view than those in the commercial sector.

However, it is very important that the priorities and resources be allocated to the KDU by the Sri Lankan MoD. To ensure that adequate effort be allocated to long term research this should be done in a collaborative manner between the Sri Lankan MoD and KDU. It is understood that there is a very good relationship between the Sri Lankan MoD and KDU, with many senior positions at KDU being held by members of the Sri Lankan MoD.

In addition to conducting short term S & T activities for defence, staff at KDU will have an ongoing interest in longer term research, and provided there is good collaboration between them and the Sri Lankan MoD there is the opportunity to get a good balance between short term and long term research.

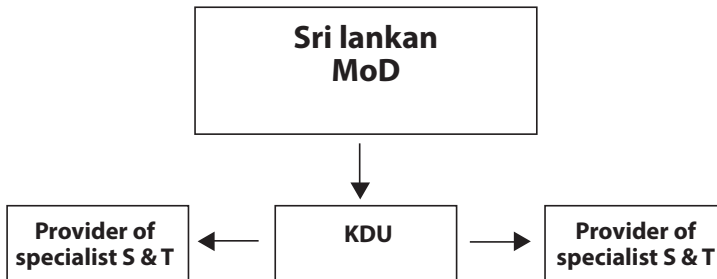
The KDU is also very likely to be very well placed to provide the “watching-brief” on those commercial technologies which the Sri Lankan MoD judges are not priorities for defence resources.

However, there may be some fields where KDU is not the best source of S & T in Sri Lanka. In these cases the Sri Lankan MoD could contact a third party to conduct that work, as shown in figure 7.2. However, if this process were to be managed in this way, then the Sri Lankan MoD would need to establish a hub to place such contracts, and monitor the activities of the organisation doing this. This will have many of the disadvantages of the approach suggested in section 7.3.



**Figure 7.2 Possible involvement of KDU and specialist S & T organisations managed by the Sri Lankan MoD**

Hence, an alternative procedure could be for the KDU to contract and oversee the work done by any specialist S & T provider, as shown in figure 7.3.



**Figure 7.3 Possible involvement of KDU and specialist S & T organisations managed by the KDU**

This has the advantage that the Sri Lankan MoD doesn't need to establish its own specialist hub to manage third party S & T activities. This will be done by KDU, which will already have research staff, who presumably would be better placed to manage the S & T conducted by any third party organisations than the Sri Lankan MoD.

This model works very well in Australia, where the Defence Science & Technology Group (DST) places contracts with specialist commercial companies and universities where required to obtain the best S & T available in Australia. As DST has extensive experience with S & T it is well placed to determine which organisations can best provide the required S & T expertise, and then to manage them.

DST also fosters relationships with universities and commercial companies in Australia, in order to be able to contract them to conduct S & T in specialist fields as required.

With this model KDU would be able to represent Sri Lanka in any partnership arrangements with the defence S & T organisations in other countries. Being government there should be no problems with this.

KDU would be able to provide the continuity required for long term research. It is also very well placed to understand what S & T is being conducted in the commercial sector, and hence to keep a watching brief on this for defence applications.

KDU is also well placed to benefit from dual use S & T, where its researchers can conduct both S & T for defence and for non-defence applications as required.

For KDU to take on the leading role in conducting S & T for the Sri Lankan Ministry of Defence then it is quite possible that additional funding will be required. This is extremely likely to be a much cheaper option than the creation of a new S & T organisation within the MoD.

## 8. RECOMMENDATIONS

It is recommended that:

**8.1 The Sri Lankan MoD establishes a mechanism to undertake defence related Science & Technology in the country.**

**8.2 Consideration be given to each of the three following possible options for establishing defence related Science & Technology in Sri Lanka**

- a) Creation of a new defence S & T establishment within government which conducts all defence S & T for Sri Lanka;
- b) Outsourcing all defence S & T activities to the private sector in Sri Lanka; or
- c) Making use of the existing General Sir John Kotelawala Defence University as the prime defence S & T organisation in Sri Lanka.

## 9. CONCLUDING COMMENTS

It is universally accepted that having access to the latest military science & technology is of vital importance to any nation's defence force. This is the case now, as it always has been. There are many examples in history of cases where a numerically smaller military force has triumphed over a larger one due to its superior military equipment. As the pace of technological developments increases it is certain that this is going to become even more important in the future.

Thus, it is vital that the Sri Lankan MoD establishes a mechanism to undertake defence related Science & Technology in the country.

This could be done by: establishing a new defence Science & Technology establishment within government which conducts all defence Science & Technology for Sri Lanka; by outsourcing all defence Science & Technology activities; or by a partnership with the existing General Sir John Kotelawala Defence University. It is recommended that each of these options be considered.

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*Technical  
Session*

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(ORAL & POSTER PRESENTATIONS)

# CHANGING DYNAMICS IN THE INDIAN OCEAN: GEOSTRATEGIC COMPETITION AND CHALLENGES FOR SRI LANKA

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**Abstract** – The Indian Ocean has become an area for geo-strategic competition since there are strategic security groupings and contest for influence. The uni-polar world dominated by the world's sole super power, the USA, is being challenged by emerging super powers such as China, India, Russia and Japan. The Indian Ocean plays a key role in this 'Asian Century'. This ocean is heavily militarized and nuclearized, and consist of large number of flash points, which can erupt into a conflict anytime.

There is an unofficial 'cold-war' brewing up here. The Indian Ocean is also the world's economic life line in trade and is considered as the energy super highway. There are many players either in, or interested in the Indian Ocean and these include large number of non-state actors as well. Maintaining the freedom of maritime commerce and a rule based international maritime order in this ocean is essential for peace and prosperity of the whole world. Sri Lanka, which is located in the centre of this ocean, is subjected to spheres of influence of major players and need to charter its course very strategically in the future. Sri Lanka's destiny has always been shaped by the ocean and its location. All invasions have come across the sea.

The country's future lies on how it exploits the blue ocean to her advantage. Sri Lanka cannot remain immune from what is happening in the neighbourhood and even the Western Pacific, and need to make extremely calculated choices to face the emerging realities and narratives of the ocean surrounding the country. This paper is based on an exploratory research method to understand the way forward for Sri Lanka in these turbulent waters. The data collection and analysis is based on qualitative interviews and literature review and analysis will be based on the grounded theory.

**Keywords** - Indian Ocean, Geo-strategic Competition, Maritime Security, Challenges for Sri Lanka.

## I. INTRODUCTION

### A. The Indian Ocean.

The Indian Ocean is the third largest water-body on planet earth. There are two billion people living in the Indian Ocean Region (IOR). This ocean has played a strategically significant role in the history. Its strategic significance has now become even more important in this 'Asian Century'. The IOR connects the world through an extensive shipping network that links Asia, Oceania, Africa and the rest of the world. Hence, the developments in the IOR only affect the regional

countries, but also the world at large. The IOR has gained importance as the world's 'Energy Highway' and an area of emerging economic and military power rivalry. The economic interactions across this ocean have increased in the recent past and there is a new world economic order shaping upon its waters.

The IOR has attracted the attention of major naval powers of the world and this ocean has now become the most militarized ocean in the contemporary world. In 2009, piracy in the Horn of Africa compelled major naval powers to come to this ocean to safeguard their merchant marine from this menace. Piracy, which threatened the maritime commerce in the Western Indian Ocean, has declined over the years, but has not been completely eradicated. Yet, international navies are still operating here.

## B. Maritime Cold War.

There is an unofficial 'maritime cold war' brewing up in the Indian Ocean. However, confrontations involving major maritime powers are unlikely at this juncture, due to the fact that states are focusing on economic development and a war-environment would not be conducive in the economic endeavours. Nonetheless, threats to freedom of maritime commerce can come from a variety of non-state actors. Violent extremist groups; human smugglers; illegal weapon and narcotic traders, Illegal, Unreported and unregulated fishermen, as well as pirates are focusing their attention on IOR to carry out illegal activities. Therefore, guaranteeing freedom of the high-seas and maritime security has become a critically important factor governing international maritime activities.

## C. Maritime Security

Maritime security in the IOR has now become a dynamic and multifaceted concept due to the complex nature of players, their networks and motives. There are few unstable states within the IOR. These potential flash points pose a serious threat to the freedom of maritime commerce in this ocean. There are also several choke points at key entrances/exits to and from the Indian Ocean. The choke points at Bab-El-Mandeb and the Strait of Hormuz in the Middle-East have the potential to seriously impact freedom of navigation. Further, as the connector to the Pacific Ocean, the Indian Ocean is not totally immune from the developing security situation in the Western Pacific Ocean and the spill over effect of that is clearly seen here.

## D. Sri Lanka in the Indian Ocean

Sri Lanka is a small Island nation located in a key geo-strategic location in the Indian Ocean. Admiral Harris, the United States Navy's Pacific Commander, whilst attending Galle Dialogue international seminar in November 2016, indicated that the strategic significance of this country as "Location, Location and Location" (Harris, 2016.p.11). The United States is a major power in the Indian Ocean. The value of the location of Sri Lanka for USA and other major players is clearly expressed in the above statement. As per Colombage "The Island of Sri Lanka has only one frontier, the sea. Even the early seaborne travellers were cognizant of this fact. This appreciation of Sri Lanka's uniqueness did not happen overnight. It was an awareness built up over centuries of contact with other nations of the world, particularly other maritime nations. The island's

insularity from mainland Asia was known by other non-seafaring kingdoms too. It is this awareness that has shaped the history of Sri Lanka" (Colombage, 2017. p. 48). The island, Sri Lanka, can be considered as the southernmost landmass of Asia, since there is no other land mass between Sri Lanka and the South Pole. Geographical location has often been a key enabler for Sri Lanka to attract many a nation to focus their strategic attention on its position. In this regard, Silva describing the importance of location says; "In a geographical and historical context, the greatest attraction of Sri Lanka was her location in relation to the rest of the world, from where she had functioned as a midway island fortress, situated longitudinally halfway on the eastern meridian and laterally almost on the equator" (Silva, 2013. p. 20). Sri Lanka is trapped between the major power rivalry, especially between India and China. During the long-lasting conflict which ended in 2009, Sri Lanka needed weapons and other military equipment to fight against the Liberation Tigers of Tamil Eelam (LTTE) and many western countries and India had enforced an official and unofficial embargo on providing lethal weapons to fight the war.

However, China was willing to provide weapons to fight even on long term credit and established a bonded warehouse in Sri Lanka for the military to obtain required arms and ammunition. That support was crucial in defeating the LTTE in May 2009. When the war ended, there was a need for an accelerated development of devastated and ineffective infrastructure projects, and western countries did not come forward to undertake any major projects citing human rights considerations. The western countries, together with India, even went to the extent of passing resolution against Sri Lanka in the United Nations Human Rights Commission (UNHCR). China again came forward to fill the strategic vacuum and became the main development partner for Sri Lanka, although it has now led to a debt burden for the country.

## II. RESEARCH PROBLEM AND OBJECTIVE

Sri Lanka, which is located in the centre of the Indian Ocean, is subjected to spheres of influence of major players and need to charter its course very strategically to the future. Sri Lanka's destiny has always been shaped by the ocean and its location. All invasions have come across the sea. The country's future now depends on how it exploits the blue ocean to her advantage. Sri Lanka cannot remain calculated choices to face the emerging realities and narratives of the ocean surrounding the country.

Sri Lanka has come out victoriously after battling a violent insurgency, which devastated the country and retarded the progress by a few decades. Sri Lanka cannot afford to miss this opportunity to develop the country economically and fulfil the infrastructure needs of its population. Sri Lanka should capitalize on the attention it is receiving due to the geostrategic competition in the Indian Ocean by major economic and naval powers present in the region. Sri Lanka's foreign policy and international relations at this juncture would determine the future of the country. The objective of this research is to understand the complex geostrategic situation in the Indian Ocean and to identify how Sri Lanka should charter its course in navigating to the future.

### III. METHODOLOGY

This research is aimed at examining the phenomenon of geostrategic competition and spheres of influence of the major players in the Indian Ocean in order to undertake a more detailed in-depth study regarding the way Sri Lanka should handle this situation to develop the country in to a stable, secure and prosperous nation. The researcher will attempt to seek to understand social reality in its own terms, through talk and interaction, to gain access to inside experience and hence will follow the key traditions of qualitative research. The main research methods associated with qualitative research such as participant observation, discourse and conversation analysis will be used to collect data. A literature review will be carried out to understand various aspects of the situation. Theories of International Relations will be used to analyze the research findings. The data analysis will be done using interpretive paradigm to find the meaning of data collected by the researcher. The geostrategic situation in the Indian Ocean will be considered as the independent variable and foreign and economic policies of Sri Lanka will be the dependent variables.

#### E. Data Analysis

Grounded theory has become the most widely used strategy for the purpose of analysing qualitative data. Strauss and Corbin (1988, p. 12) describes the grounded theory as 'theory that was derived from data, systematically gathered and analysed through the research process. In this method, data collection, analysis and eventual theory stand in close relationship'. This research was aimed at generating theories to find a lasting solution to a protracted conflict. There were no grand theories selected in this

research for testing. Rather, it will allow the generation of theories through systematic collection of data and analyses. The researcher will look at interconnectedness of action through data analysis. As Bryman states 'coding is one of the most central processes in Grounded Theory. It entails reviewing transcripts, and/or field notes and giving labels (names) to component parts that seem to be of potential theoretical significance and/or that appears to be particularly salient within the social worlds of those being studied' (Bryman, 2008, p.542). In this research, Selective coding is being used to identify core categories and then to identify the interconnectedness and relationship between the core category and other categories.

#### F. Theories of International Relations

A theory of international relations is a set of ideas that explains how the international system works. The two major theories of international relations are realism and liberalism. As stated by Smith (2013), "The study of International Relations has clearly focused on the analysis of the causes of war and the conditions of peace". International relations and power politics are increasingly related to economic activities in this globalized world. This research will focus on finding answers to the following questions through the study of International Relations

- a. How does the Inter-state power relations take place in the Indian Ocean?
- b. What are the effects on smaller less powerful states, such as Sri Lanka, due to the power rivalry in the Indian Ocean?
- c. How could Sri Lanka survive in these major power struggles and overcome the challenges?

If all actors have similar security needs and perceptions, and they cooperate with one another, all can benefit. However, this is very difficult in the international system as it is difficult to identify the interest of nations or whether they will genuinely cooperate. This is the maritime security dilemma present in the Indian Ocean. Balance of power predicts that rapid changes in international power and status, especially attempts by one state to conquer a region, will provoke counterbalancing actions. For this reason, the balancing process helps to maintain the stability of relations between states.



## IV. DISCUSSION

### G. The Indian Ocean Region

The Indian Ocean region is home to nearly one-third of the world's population and is of high economic and strategic significance due to its location and traffic that passes through it (Daniel, 2016).

It is estimated that nearly half of world's containers, one third of bulk cargo traffic and two thirds of the world's oil shipments pass through the India Ocean (Bergin, 2012). Hence the sea lanes through this region is not valuable only to the Indian Ocean littoral countries but to the entire world. This ocean is now becoming the key ocean in the world surpassing the prominence enjoyed by the Atlantic and Pacific Oceans during the last two centuries. The global economic balance is swinging towards Asia and the Indian Ocean plays a significant role in this new shift. Therefore, the geopolitical and geo-economic importance of the Indian Ocean is growing at a rapid pace. India is the main player in the Indian Ocean. With a rapid developing economy and the largest navy in the region, India naturally looks to assert its position in this region. Sri Lanka is invariable within the security umbrella of India, especially in the maritime domain and airspace due to the close proximity of the two countries. Raja Mohan reasons out that New Delhi's new interest is driven by the growing importance of trade, especially seaborne trade, in India's economy (Mohan, 2016). This is why Shiv Shankar Menon, former Secretary of State, wrote in his book Choices that "Sri Lanka is an aircraft carrier parked fourteen miles off the Indian coast" (Menon, 2016.p. 143). India will not tolerate its national security being threatened by an outside power who might have a foothold in Sri Lanka. Sri Lanka should be very mindful of this consideration.

### H. The Indian Ocean as a Global Commons

The Indian Ocean cannot be seen merely as a localized ocean. It is pretty much a part of the global common and maritime commerce. It is the life line not only for the Indian Ocean littorals, but for most of other developed and developing economies such as China, India, Japan, South Korea and hence ocean governance is essential. As per Rear Admiral Goldrick, "Traditional great power naval competitions are re-emerging after a quarter-century hiatus (Goldrick, 2016. p.99). His argument is based on the premise that some countries believe that there should be open seas policy in the Indian Ocean as

is the international norm but few countries feel that the ocean should be having restricted use for non-resident navies. This has led to a conflict situation and escalating tension between maritime powers.

### I. The United States of America (USA) in the Indian Ocean

The USA, the world's only super power, is conscious about declining of its uni-polar power projection, especially in the Indian Ocean. Their main focus, however, is the Western Pacific Ocean. China's unilateral action in the South China and East China seas and the developing situation in North Korea are two major concerns for USA and its allies in the Western Pacific region.

The unpredictable behaviour of North Korea is worrisome for Japan and South Korea, who are partners of USA and depend heavily for their security. Therefore, the USA is keen to maintain sanctity in the Indian Ocean. Therefore, the USA will remain the leading security provider in the Indian Ocean and will remain so in the foreseeable future as well. India, despite having the biggest navy in the region, still depend on USA to act as a guarantor of maritime security. Enhanced cooperation between India and USA in defence procurements and technology transfers and formally signing of Logistic Exchange Memorandum of Agreement, in 2017, after years of negotiations since 2004, are clear signs of this aspect.

This agreement would facilitate access to each other's military facilities for logistic during port calls, joint military exercises, military training, disaster relief operations and humanitarian operations (IDSA, 2016). India has now become the biggest buyer of US weapons and this fact was even appreciated by the US president when the Indian Prime Minister Modi visited Washington in July 2017 (Natarajan, 2017). The USA with their major naval facility in Diego Garcia is interested in maintaining freedom of navigation in the Indian Ocean. The USA maritime force's Cooperative Strategy for 21st century Sea power (US Coast Guard, 2015. p. 11) states that "With strategic attention shifting to the Indo-Asia-Pacific, we will increase the number of ships, aircraft, and Marine Corps forces postured there. By 2020, approximately 60 percent of Navy ships and aircraft will be based in the region". This is the official version of the US government and gives a clear indication of their commitment to maintain naval presence in the IOR. USA is now engaged with India, Japan, and Australia in conducting joint naval exercises as well.

### J. China as a Major User of the Indian Ocean

China is another major economic and maritime power presently operating in the Indian Ocean. Koh indicates China's concern as, "Energy security remains a perennial concern for Beijing since it underpins sustained economic growth that forms the basis of peaceful development" (Koh, 2016, p.148). China has shown a keen interest in maintaining unimpeded access to the Indian Ocean shipping lanes as it depends heavily on petroleum transport from the Middle East and East Africa. Also, China is dependent on the Indian Ocean to transport their export products to Europe, Africa and South Asia. Therefore, China is enhancing its strategic outlook and wishes to maintain its presence in the Indian Ocean. Chinese involvement in development projects in Sri Lanka was not seen favourably by India, USA and even Japan. From a western perspective, Sri Lanka, to be precise the port of Hambantota, is a pearl in the 'String of Pearl' theory. Colombo International Financial City (Formerly known as Port City) and Hambantota port projects, undertaken by Chinese companies with Chinese EXIM bank loans, are being looked at with suspicion mainly by India, which was alarmed that these two projects would be used by China to ensure a strategic military foothold in the Island nation.

### K. India in the Indian Ocean and Strategic Competition

India and China are fast emerging major powers in the Indo-Asia-Pacific region. As their economic power, wealth and strategic interests expand, they increasingly come into contact with each other. The security relationship between these two countries are volatile as they have unresolved land borders. New Delhi perceives the growing Chinese presence in South and South-East Asia, East Africa as an attempt by China to form strategic alliances and military facilities that could be used against India. Both countries are linked through trade but the balance is in favour of China. India has to counter not only growing Chinese presence in the Indian Ocean, but the developing 'all-weather' friendship between China and Pakistan. The China Pakistan Economic Corridor (CPEC) is seen by India not as an opportunity but as a threat to their sovereignty. India argues that CPEC is not merely an economic oriented project but another attempt by China to encircle India strategically. This negative dynamic is the main contest for power in the Indian Ocean. China believes that it has the right to freedom of navigation in the Indian Ocean like any other maritime power and

they need to protect their maritime commerce, including energy supplies. Sri Lanka is caught up between this power dynamic. India with its 'look east' policy is increasingly looking to USA and Japan to partner in maintaining freedom of navigation in the Indian Ocean.

### L. Japanese Concerns and relations with Sri Lanka

Japan is another major player who is interested in maintaining freedom of navigation and a rule based maritime order in the Indian Ocean. Nagao indicates that "a new dynamic is prevailing in Japanese foreign policy" (Nagao, 2017. p.1). A paradigm shift has taken place in Japanese foreign policy in the recent past. In September 2015, Japan amended its constitution to allow its military forces to play a more effective role in maintaining world peace and a more robust role in the maritime domain to ensure the safety and freedom of maritime commerce. This change has paved the way for the Japanese Maritime Self-Defence Forces (MSDF) to participate in a number of overseas operations in the recent past. This is a move away from the mere protection of homeland role for MSDF. Japanese Prime Minister Abe emphasized this policy indicating that "Free and Open Indo-Pacific Strategy" of Japan and their determination to shoulder a major role and responsibilities as a major user of the IOR (Press Conference, 2017)

Japan looks to Sri Lanka as a key partner together with USA and India. Japan has pledged to support the development of Sri Lanka Coast Guard (SLCG). Japan pledged to build two 30-meter patrol boats for the SLCG in Japan. Beginning of 2017, the SLCG also placed an order for the construction of two 85-meter Offshore Patrol Vessels (OPV) with the Colombo Dockyard (Pvt.) Ltd. (CDL) to enhance its capabilities in deep sea surveillance. This project too will be undertaken by a loan provided by the Japanese government (Colombage, 2017). These two OPVs will have the capability for the launch and recovery of helicopters and small utility boats at sea. There had been many high-level visits by Japanese maritime delegations to Sri Lanka and SLCG has benefitted immensely from these visits and is receiving a higher level of training and skills development on maritime disaster measures, particularly on oil spill combat skills, from the Japanese Coast Guard. Japanese marine environment protection and oil spill measure experts have been conducting regular courses and drills with the SLCG to enhance the latter's level of competency in emergency response procedures in maritime pollution activities. Japan has also donated equipment, along with skills training.

### **M. Maritime Cold War in the Indian Ocean**

This renewed interest also aims at countering rising Chinese influence in the region and in Sri Lanka. There are other state players such as Russia, South Korea and ASEAN countries that depend on the freedom of maritime commerce in this ocean. Despite the presence of a large number of powerful navies and heavy militarization of the Indian Ocean, a major confrontation between states is unlikely in the present scenario as the states are more focused on economic development and hence the tension is low. All the states are following a rule based maritime order and attempt to cooperate and collaborate in enhancing maritime security. However, there is an undeclared maritime cold war taking place in this ocean.

### **N. Non-state Actors in the Indian Ocean.**

States are not the only players who are exercising interest in this ocean. There are a variety of non-state actors who are using and trying to develop their capacities in the Indian Ocean. These actors could include, pirates, illegal drug and weapon traders, religious extremists and terrorists, Illegal unreported and unregulated (IUU) fishers and human smugglers. The world witnessed the impact of Somali piracy in the Horn of Africa and the Western Indian Ocean (WIO) in the recent past. International navies were compelled to come into the Indian Ocean to protect their merchant marine from attacks by Somali pirates. There are International task groups and individual naval ships engaged in counter piracy operations. There are also on board armed security guards deployed in most ships traversing the Indian Ocean. Due to these combined efforts, piracy has decreased. Maritime piracy and armed robbery against ships have dipped to the lowest number in five years, according to the ICC International Maritime Bureau (IMB) report, though the decline has been marred by the more serious incidents of vessel hijacking (Liang, 2017). However, the international navies are still operating in large numbers in the pretext of countering piracy. Sri Lanka should increasingly look to the ocean for living and non-living resources and alternate energy. Sri Lanka will have to ensure that the marine environment is protected from IUU fishers who are engaged in destructive fishing methods. There are also drug smugglers who are always trying to stay ahead of law enforcement authorities and to carry on with their nefarious activity. Sri Lanka should not allow its territory and the ocean be used by transnational drug traffickers, whether it is heroin from Afghanistan or Kerala Ganja (Cannabis) from India. Religious extremism and fundamentalism are two other threats from the Non-

state actors in the regions. There should be a collective mechanism to share intelligence and combat the spread of these extremist ideology.

## **V. CONCLUSION: STRATEGIC DILEMMA FOR SRI LANKA**

The strategic competition by major powers in the Indian Ocean invariably put the smaller states like Sri Lanka in a strategic dilemma. India's 'Look East' policy, USA's 'Cooperative Strategy for 21st century sea power' and Japan's 'free and open Indo-Pacific Strategy', have found a convenient strategic convergence of this maritime trinity in the Indian Ocean. The three major maritime powers have developed a 'strategic Global Partnership' in the Indian Ocean mainly to counter Chinese foray in to this ocean. China, with its newfound wealth and modernized maritime power has clearly stated that they need to perform a maritime role beyond their local domain and especially in the Indian Ocean, since they depend heavily on this ocean for their energy supplies and to continue with trade. China's unilateral behaviour in the Western Pacific Ocean gives rise to suspicion of major maritime powers that China would aim to develop military facilities in the IOR as well.

### **O. Sri Lanka as the Maritime Hub of South Asia**

Sri Lanka's aspirations to be a maritime hub of the region goes well with the China's Belt and Road Initiative (BRI) as it is aimed at developing port and related infrastructure to facilitated trade connectivity across the 21st century maritime silk road. Recently, India and Japan launched their own initiative named Asia-Africa Growth Corridor (AAGC) to counter the Chinese BRI. The vision of AAGC as stated by the Prime Minister Modi is to "Propel growth and Investment in Africa and to create a free and open Indo-Pacific Region by rediscovering ancient sea routes and creating new sea corridors to link African continent with India, South and South-East Asia" (Basu,2017). Countries such as Sri Lanka which are aspiring for economic development may most probably be forced to choose between the BRI and AAGC. This is a clear indication that Sri Lanka is in a strategic dilemma and invariably, this is hampering the economic growth of the country. Sri Lanka cannot ignore the geo-political and geo-strategic reality and concerns of major players in the region and especially that of India. India is Sri Lanka's closest neighbor and the fastest developing economy in the region with the most powerful navy and the coast

guard. India sees itself as the preeminent maritime power in this ocean and does not like to see other maritime powers, especially China trying to influence its neighbors. Sri Lanka is well within the spheres of Indian maritime and air strategic area of interest due to the close proximity and shallow unnavigable water body, Palk Strait separating the two countries. Sri Lanka cannot afford to provide military facilities to any other country, which are not considered friendly by India. Sri Lanka need to leverage its geographical location and maintain unbiased relations with all the stake holders but without upsetting India. Sri Lanka can benefit from BRI or AAGC for economic development. How Sri Lanka handles its strategic location to leverage international, regional relations will determine its future.

**P. Recommendations**

- 1) Sri Lanka need to move away from being reactive to the interests of its neighbors and prospective partners and take proactive initiatives to benefit from global shift in economic power by focusing on ‘commercial Diplomacy’ as highlighted by the Minister of Foreign Affairs, Ravi Karunanayake (Daily FT, 2017).
- 2) Sri Lanka need to carefully enhance economic cooperation with major players in the Indian Ocean and obtain the much-needed Foreign Direct Investment (FDI) to develop its economy. The economic interdependence could be considered as a way to reduce strategic mistrust and increase mutual dependency. Sri Lanka should be careful not to develop closer relations with a particular country at the expense of another, especially India.
- 3) Sri Lanka need to enhance defence cooperation and cooperative relationships with all players in the region and play a more effective role in maintaining freedom of navigation in the region. Sri Lanka is in an ideal geographical location to act as a catalyst for regional cooperation. Sri Lanka has the unique advantage of being easily accessible for all the countries due to its balanced foreign policy and should make use of this opportunity to play a more strategic role than its comparative size.
- 4) Sri Lanka should become the center for Maritime Domain Awareness (MDA) for the region to share information on non-military shipping, by capitalizing its vantage geographical location and ease of access for major maritime users in the ocean.
- 5) Sri Lanka should focus of carrying forward the initiative it has launched on developing a Code of Conduct (COC) for Major Maritime Users (MMU) in the Indian Ocean, which should ensure that all stake holders abide by the internationally accepted, Rule based maritime order in the Indian Ocean.
- 6) Sri Lanka should also focus more on developing its Coast Guard capabilities so as to allow it to operate as a standalone coherent unit and to perform more constabulary and law-enforcement missions and to prevent maritime crime and pollution in the region.

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Admiral (Dr.) Jayanath Colombage is a former chief of Sri Lanka navy who retired after an active service of 37 years as a four-star Admiral. He served the Sri Lanka navy during the entire spectrum of war with the LTTE Terrorism and commanded various ships and four naval areas. He is well known expert in maritime security issues in the region and has held important positions in Sri Lanka's maritime sector. He holds MSc on defence and strategic studies from Madras University and MA on International Studies from Kings College, London. He also holds a PhD from General Sir John Kotelawala Defence University. Currently he is employed as the Director of The Center for Indo-Lanka Initiatives at Pathfinder Foundation

# STRATEGY TO OVERCOME MARITIME BLINDNESS: THE SRI LANKAN CASE

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**Abstract** - The strategic location of Sri Lanka in the Indian Ocean not only make the island a vital connecting nod for the East-West maritime traffic, but also behaves as a centre to monitor the entire ocean space that spans to the southern tip of the globe. The importance of knowing the activities that are taking place in a country's ocean space is a very critical factor in ensuring maritime security. The vastness of the ocean space and the inability to monitor each and every inch of the ocean is a major challenge faced by many navies. Further Increased apprehensions have made impacts on drug trafficking, human smuggling, gunrunning, piracy, etc. Within this context Sri Lanka Navy has taken measures to tackle those illegal activities.

The Sri Lankan ocean space comprised of an EEZ that is seven times larger than the land, continental margin around twenty one times larger than the land and a search and rescue region around twenty seven times larger than the land area. By every means it shows that this is a huge area to conduct effective surveillance by utilizing assets and sensors. As a consequence of that limitation there are number of illicit activities that take place in surface and subsurface water Therefore, an effective maritime surveillance strategy is essential to minimize the strategic maritime blindness Sri Lanka is facing at present.

The prime objective of this research is to formulate a strategy to reduce the maritime blindness in the Sri Lankan ocean space with the assistance of regional as well as global partners. When formulating a strategy, it is essential to analyse existing maritime surveillance mechanisms and advanced sensors used by other navies. However, the strategy should also focus on how best the navy could use available assets as well as new acquisitions under three dimensional visibilities (Above, Surface and Subsurface) on ocean affairs.

**Keywords** - Maritime Security, Maritime Blindness, Maritime Surveillance.

## I. INTRODUCTION

The strategic location of Sri Lanka in the Indian Ocean not only make the island a vital connecting nod for the East-West maritime traffic, but has the potential to monitor the entire ocean space that spans to the southern tip of the globe. The importance of knowing the activities that are taking place in a country's ocean space is a very critical

factor in ensuring maritime security, under the broader realm of National Security

With the military defeat of enemy in 2009, the maritime space of Sri Lanka became free from maritime terrorism. We do not have a visible enemy out at sea at present. Yet, this does not mean that our seas are safe and secure (Joseph 2015). At present we have maritime security threats and challenges that are quite common to many regional countries. Drug trafficking, human smuggling, IUU fishing, marine pollution, responding to SAR, oil/chemical spills, piracy etc., are some of the common challenges which take place mostly utilizing the high seas.

The sensors and platforms the Sri Lanka Navy (SLN) is in possession today is only capable of conducting maritime surveillance in the near shore areas and up to a certain extend in the Exclusive Economic Zone (EEZ). The Sri Lankan ocean space comprised of an EEZ that is seven times the land, continental margin around twenty one times the land and a search and rescue region around twenty seven times the land area. By every means this is a huge area to conduct effective surveillance utilizing assets and sensors available at present. Apart from the limited surveillance capabilities of the ocean surface, we are completely blind on subsurface activities that take place in terms of submarine operations. The increased presence of Chinese submarines has created tension especially among Indian officials (Mahadevan 2014).

When vital information pertaining to the activities that are taking place in the maritime space as well as adjacent highs are not available with decision makers, it leads to a number of issues such as; difficulty in implementing the national maritime strategic policies, achieving navy's maritime strategic ambitions, ensuring safety of sea lines of communication (SLOCs), continuity of trade and energy lines etc. Therefore, as a maritime nation that aspires to become a leading maritime hub in South Asia, Sri Lanka is in need of an effective maritime surveillance strategy to minimize the maritime blindness in order to achieve broader maritime objectives (Joseph 2015).

This research therefore looks at the problem statement of 'as to what extent does the introduction of a strategy to minimize maritime blindness would address key strategic maritime concerns of Sri Lanka? The prime objective of undertaking this study is to formulate an effective strategy to minimize the maritime blindness by way of introducing additional platforms to the navy, incorporating advanced maritime surveillance sensors/equipment, formation of a cooperative strategic maritime surveillance architecture with the assistance of regional as well as other partners, fusion and sharing of vital sensory information with regional navies and maritime law enforcement agencies.

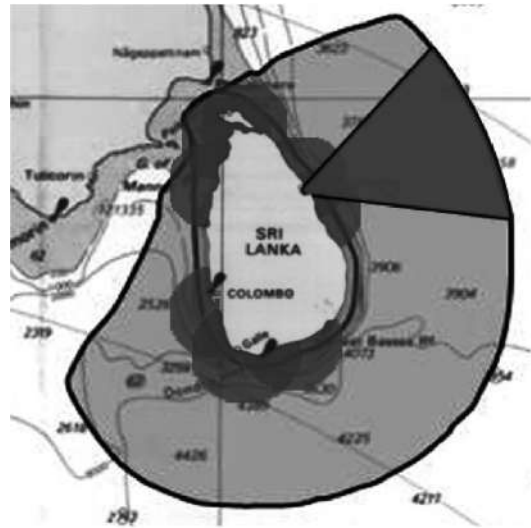
## II. METHODOLOGY/ EXPERIMENTAL DESIGN

The research design for this study has been formulated based on the research design concepts introduced by Sekaran and Bougie (2010). Having identified the key variables in this study, the research design looked at identifying methods required to gather data, how analyses have to be done and finally to arrive at a solution. The research is based on ascertaining the characteristics of the variables of interest.

In this study a very basic research methodology is followed in order to analyse the present capabilities of the Navy in effectively conducting maritime surveillance in the near shore areas as well as in the much important high seas. The study is descriptive in nature and follows a correlation investigation method. The researcher has a very minimal interference with the study and was done in a non-contrived setting and data was gathered just once over a period of one year.

The primary data for this research was gathered by analysing the surveillance capabilities of the naval

platforms as well as other shore based sensors located around the coastline of Sri Lanka. Figure 1 shows the present coverage of surveillance areas around Sri Lanka based on the detection range (in red and blue). This figure very clearly depicts that there are considerable number of areas which does not have surveillance at all.



**Figure 1. Present surveillance coverage**  
**Source: Directorate of Naval Operations**

Figure 2 shows the apprehensions made by the Navy out at sea during the last year. It clearly depicts that almost all the apprehensions are made well within the territorial waters of Sri Lanka.

Naval platforms which are capable of operating in deep seas numbered to nearly nine with the expected new acquisitions. SLN's Maritime Strategy 2025 document (non-public limited circulation) looks at forming a twenty ship Navy by 2025 mainly comprising of frigates and offshore patrol vessels. Navy does not have a single underwater vessel or sensors which are capable of detecting submarines at a considerable range. In addition, the Air Force does not have a single dedicated long range maritime patrol air craft to carryout air surveillance covering the vast ocean space.

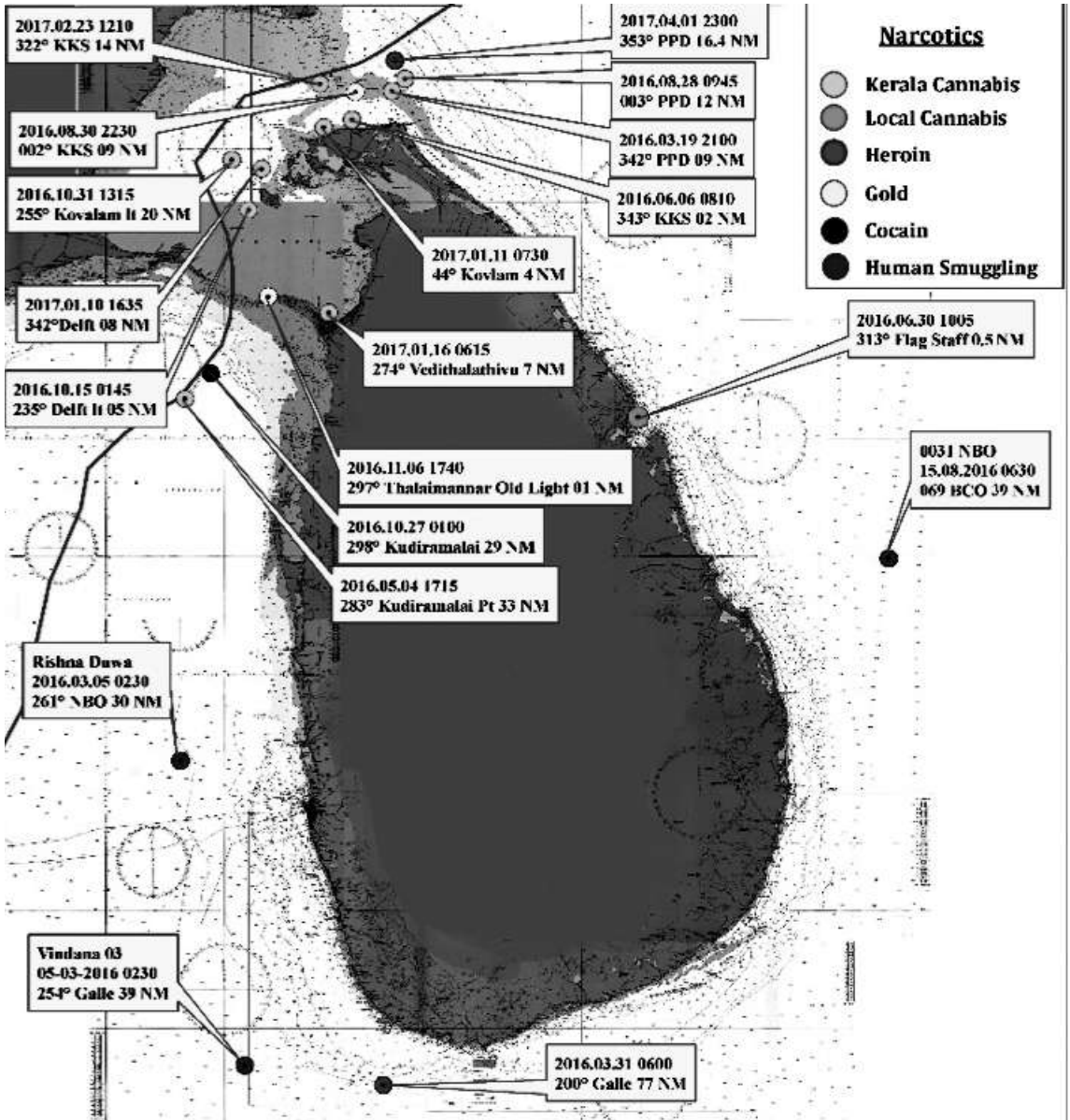


Figure 2. Maritime apprehensions by Navy  
Source: Directorate of Naval Operations



### III. RESULTS AND DISCUSSION

The above situation is one of the main reasons why there are so many blind spaces in our EEZ as well as the adjacent high seas. We have no clue what so ever of what is taking place or who is out there in the areas where no surveillance is available. This directly affects the maritime security of Sri Lanka which in turn has a direct impact on the broader aspects of National Security.

Analyses of data pertaining to maritime apprehensions during the last year clearly shows that navy's apprehensions have been primarily in the territorial waters or in the EEZ. When we look at the human smuggling arrests made in the deep seas, they are result of the high level of bilateral cooperation between Sri Lanka-Australia (Colombo Declaration, submitted by Sri Lanka 2017). Highly reliable and timely intelligence have enabled the naval units to intercept human smuggling boats in the deep seas.

Apprehensions made by the Navy and repeated arrests made indicates that the illegal actors are using the lightly governed ocean space for their advantage. Most probably, knowing the limitations of the surveillance capabilities of the navy, they are increasingly moving to the maritime space to carry out illegal activities.

Except Sri Lanka, all the nations in the neighbourhood have acquired submarines to their naval fleets. The latest country to acquire a three dimensional force is Bangladesh. Leaving aside the availability of submarines in SLN fleet, we do not even have a single sensor which is capable of detecting a submarine at a considerable distance. This leaves the navy in a total blindness with regard to subsurface maritime affairs. The increase presence of especially Chinese submarines in the Indian Ocean has been discussed in length (Mahadevan 2014). The presence of Chinese submarines is known, but what about those that continues to frequent the Indian Ocean without being detected? This is indeed a grave concern for maritime security affairs of Sri Lanka as well as to the other regional countries. The inability to have a clear image on the activities that take place in the EEZ makes the country vulnerable to IUU fishing by foreign fishermen and probable exploitation of scientific data from the Sri Lankan EEZ.

The following strategy was formulated to minimize the maritime blindness the Navy is facing at present by formulating a layered approach to maritime surveillance. In this, the first layer which is the territorial seas are

monitored using RADARs and by AIS shore based stations. The second layer, which is the EEZ is monitored using surface platforms, HFSWRs, and space based AIS. The third and final layer, which is the high seas (up to 1000-1200 nm) are to be monitored by space based AIS, space based RADARs, surface and air assets (Dyck 2013). The additional phase includes the integration of advanced submarine detection system to the main maritime surveillance architecture.

Having the above layered system itself will not serve the prime objective of minimizing maritime blindness. This requires synergizing with other regional partners to make the above surveillance architecture into a strategy by cooperating national maritime objectives, regional maritime security concerns, and the geo political dynamics in the Indian Ocean Region.

Improving cross-sectoral cooperation and interoperability with regional nations, strengthening cross border cooperation, and information sharing, and development of a common information sharing nod in the Indian Ocean Region will be other critical facets of this strategy (European Union Maritime Security Strategy 2014).

The SLN will be the key agency in this regard and with the establishment of a proper regional Maritime Rescue Coordinating Centre (MRCC) at Colombo under the purview of the Navy (Sunday Times April 2017), this strategy can be implemented with relevant funding considering it as a national requirement. Failure to implement this strategy will have dire impacts on the future of the country and its dream of becoming one of the leading maritime hubs in the region.

### IV. CONCLUSION

The strategic location of Sri Lanka in the Indian Ocean reminds us that the future of this country lies primarily on the ocean that surrounds her. In order to ensure that our ocean space is not used by illegal actors and not exploited by others, having a broader visibility on the entire ocean space is very crucial. At present, SLN, which is the lead organization responsible for maritime surveillance has few platforms and few sensors that are capable of conducting surveillance in a limited ocean space. This situation leaves the nation left with huge maritime blind zones. The inability to effectively surveillance the air space over the maritime domain, ocean surface and subsurface possess a grave danger and has a direct impact on the maritime security which in turn reflect on National Security.

As there are huge gaps between what the country is capable of monitoring at present and what ideally a maritime nation must be monitoring, it is imperative that above recommended strategy be implemented considering it as a high priority national requirement.

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Captain Rohan Joseph joined the Sri Lanka Navy in October 1994 through the Kotelawala Defence University. On completion of his studies at KDU, he underwent initial Naval training at the Naval and Maritime Academy in Trincomalee. He has held number of staff and sea command appointments during his 23 year naval career. He has commanded several Fast Attack Craft, a Fast Gun Boat, Offshore Patrol Vessel and has also performed duties at the Joint Operations Headquarters, Naval Headquarters and at the Ministry of Defence. He is presently performing duties as the Naval Assistant to the Commander of the Sri Lanka Navy and Deputy Director Naval Research Wing. He completed his sub specialization in Sri Lanka becoming first in order of merit and completed his specialization in Pakistan. He is qualified in Navigation and Direction. Further, he has successfully completed his Junior Naval Staff course at the Sri Lanka Military Academy, becoming first in order of merit. Later, he completed the Staff Course at the Naval Command College, China where he excelled in his studies and graded excellent for overall academic performance. He was selected as the 'Honour Graduate' in the International Maritime Officers Course (Course no 46) conducted at the U.S. Coast Guard training centre Yorktown, Virginia. He is the first ever Sri Lankan naval officer to achieve this honour. Further he holds a Masters Degree in Conflict and Peace Studies (MCPS) from the University of Colombo. Captain Joseph's interests include reading academic articles related to world affairs, maritime security, and conflict resolution.

# ESTABLISHING A MARITIME DOMAIN AWARENESS CENTER IN SRI LANKA

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**Abstract** - In this paper researcher is interested to formulate a domestic Maritime Domain Awareness (MDA) Centre in Sri Lanka. MDA is situational awareness of the maritime environment. This could be achieved by gathering of real time maritime intelligence and surveillance. Sri Lanka is situated very close to but, away from Indian subcontinent.

Therefore sea born non-traditional security issues have arisen in the North and North Western coastal belt of Sri Lanka. The concept of MDA is a broader area in maritime security and Sri Lanka has to develop her own mini MDA system which suit to the context. Hence this is the high time to take initiatives to establish a MDA center with information sharing strategy to counter maritime threats and challenges that affect to Sri Lanka. This center will be the core unit for maritime security coordination and it will collect, analysis and disseminate relevant maritime intelligence and data to conduct maritime operations

It also depicts that the inadequacy of existing inter-agency maritime security coordination leads to increase transnational security threats. This issue highlights the significance of establishing a mini MDA center in Sri Lanka.

The objective of this paper is to identify the national requirement of establishing a mini MDA center and to identify the requirement of inter-agency synergy to counter sea born non-traditional security threats and challenges. Researcher has selected qualitative research method to collect data from the secondary sources including scholarly articles, books, case studies, journals, etc.

This mini MDA center could be a contemporary requirement of the country in order to counter existing maritime security issues. In addition, this will draw a common operational picture about the maritime domain which is relevant to maritime security.

**Keywords** - Intelligence, Surveillance, Synergy

## I. INTRODUCTION

In this paper, researcher is attempting to determine the significance of establishing a Maritime Domain Awareness Center in Sri Lanka. This concept of MDA will enable to counter existing maritime threats and challenges which come to the island. The MDA is basically a situational awareness of the maritime domain. The existing security architecture is challenged by various transnational maritime security issues. It is essential to combine civil and military maritime security components to one core unit to exchange real time maritime intelligence and surveillance

data. This will create an interagency effort involving Sri Lanka Navy, Sri Lanka Coast Guard, Sri Lanka Air Force, Sri Lanka Customs, Department of Immigration and Emigration, Department of Fisheries and Aquatic Resources, Coastal Conservation and Resources Management Department, Narcotic Bureau and Port Authority to enhance the situational awareness of the maritime domain.

MDA is mainly focusing on merchant shipping which is engaged in maritime commerce. This MDA has not so far provided answers for non-traditional security issues such as drug trafficking, IUU (Illegal unreported and unregulated) fishing and human smuggling, because these are smaller boats and smaller boats are not detected by MDA concept in a wider way. Therefore, Sri Lanka has to design a mini MDA system which would suit the Sri Lankan maritime security environment by giving especial emphasis on countering existing maritime security issues in North and North western area. This centre could be the place to collect all the information, intelligence and surveillance data and analyse them for the operational commander to take decisions on a particular situation.

This will enable to achieve quick, accurate and timely results in an operation with effective command & control and a quick decision making process.

Since Sri Lanka is situated in close proximity but, away from the Indian subcontinent, most of the non-traditional security issues are infiltrating to the country from North and North Western coastal belts of Sri Lanka. Therefore, Sri Lanka Navy has to take an initiative to establish a MDA Centre with an information sharing strategy to counter maritime threats and challenges that affects Sri Lanka. Further, Sri Lanka Navy should take an initiative to convince strategic level military decision makers to understand the real national requirement of this sort of system. The objective of this paper is to highlight the contemporary requirement of introducing a mini MDA Center to Sri Lanka.

## II. METHODOLOGY AND EXPERIMENTAL DESIGN

This research is about social behaviour of maritime security components by understanding non-traditional security threats to Sri Lanka. Most of these issues are observed from North Western Sri Lanka during the preliminary investigation by the researcher. Therefore, researcher will concentrate more on the threats in North Western Sri Lanka and establishing of MDA centre to counter those issues. This broader area of social science need to prove with logical reasoning of theories based on laws of cause and effect. Researcher will be using qualitative methods to collect data. This will be collected from the secondary source of books, articles, journals, website releases, dissertations, video and audio materials and published data of expertise in the field of maritime security. Writer expects to gather knowledge from officers and sailors experiences in the Navy in the field of maritime security and researcher's own observations. Further comparative analysis will be highlighted with Philippine MDA system and advantages of implementing such a system in the Sri Lankan context.

## III. RESULTS

### A. Concept of Maritime Domain Awareness

Maritime Domain Awareness is basically the effective understanding of anything which is associated with maritime domain which could affect security, safety and

economy of a country (Department of the USA Navy, 2009, p.2). Situation awareness is a key factor for this concept and gathering information, intelligence and surveillance are main areas under MDA. Sri Lankan maritime security components (Navy, Coastal Guard and Air Force air surveillance) and civil maritime security components (Department of Fishery, Coastal Conservation Department, Port Authority, Custom, Immigration and Emigration Department etc.) are associated with maritime activities in the country. Therefore, Interoperability of these maritime security components will enhance maritime security of the country.

This concept could be used to cultivate a common operational picture to maritime stakeholders. By establishing a mini MDA centre, civil and military maritime security components could work together. Then the operational commander will have a common operational picture of maritime domain to interdict adversaries.

### B. Maritime security threats and challenges

Sri Lankan maritime security threats and challenges are mostly appearing as non-traditional security issues. Maritime terrorism was a huge issue that encompassed our country for decades. Among the few terrorist organizations which have acquired maritime capabilities, the Liberation Tigers of Tamil Eelam (LTTE) stood as the most formidable group and they have smuggled a vast arsenal of formidable weaponry into Sri Lanka through the sea (Gunawardena, 2015) Therefore, this article identified as maritime terrorism was one of the key threats to Sri Lanka and most of the other illegal activities were the outcome of maritime terrorism. Therefore, it will be a notable challenge for maritime security components to identify these threats before infiltrating into the island.

Drug trafficking is another notable threat to Sri Lanka. It is a vast danger for the smooth functioning of social-cultural stability of the country. When narcotic infiltrates the land it paves the way for the other crimes to thrive within the country. The notable incidents of arresting narcotic items are there, but unnoticed drug smuggling activities still exist. These issues of drug smuggling are not limited to national waters of Sri Lanka. It is a highly discussed matter in the security debates in all the forums and international symposiums. "Sri Lanka continues to be utilized as a transit point for drug smuggling from the 'Golden Triangle' and the 'Golden Crescent'. Heroin is routed via Sri Lanka from Pakistan or India on a big scale by sea by containers and mechanized fishing craft"

(Wijegunaratne, 2012). Therefore, responsibility lies with civil and military maritime security components to counter these threats. Similarly Human smuggling had been taking place in Sri Lanka for a considerable period of time. However, at present this has been reduced by the effective combine operations conducted with countries within the region.

IUU fishing has caused a great impact to Sri Lankan maritime security. Most of the contraband activities are connected with IUU fishing. The Indian fishermen transgress the demarcated boundary line between the two states on a regular basis disregarding the IMBL into the Sri Lankan waters for poaching and claim that the Sri Lankan fishermen also do the same. Illegal Indian fishing trawlers and their fishermen crossing over to the Sri Lankan territorial waters has serious security implications to Sri Lanka. It certainly can have national security implications to both the countries as the possibility of a terrorist organization exploiting this conflict to carry out infiltrations and terrorist attacks is very high. However, lack of real time information sharing mechanism between the two nations has been observed. Therefore, the proposed MDA Centre could be capable of exchanging information and intelligence across borders and sectors to overcome this issue.

Non-traditional issue of transportation radioactive materials in legal as well as illegal methods has become a challenge to Sri Lanka. Nuclear rivalry between the Asian countries in the region may have made various attempts of transferring radioactive materials for their nuclear proliferation as well as nuclear energy process. Identification of these materials during transportation will be a future challenge for maritime security components in the country. Indian River Keeper Organizations describes that "Every exposure to radiation increases the risk of damage to tissues, cells, DNA and other vital molecules. Each exposure potentially can cause programmed cell death, genetic mutations, cancers, leukemia, birth defects, and reproductive, immune and endocrine system disorders (Reverkeeper, 2016). It means the radioactive material has become a threat to our maritime living and none living resources as well as to human life. This could be another future challenge for Sri Lankan border security.

### C. Maritime Intelligence and Surveillance

Sri Lanka navy is the main security component, which provides maritime security to the country. It is a fact that most of the non-traditional security issues could not be

identified at the correct time. Furthermore, there are occasions when identification becomes more difficult with the existing maritime surveillance system. Some of the occasions observed in existing maritime intelligence and surveillance capabilities and application of maritime domain concepts are insufficient to identify the issues at the precise time.

Sri Lankan fleets assets are the prime and foremost defence layer around the country which is operating in the Territorial Waters, Contiguous Zone, Exclusive Economic Zone and High Seas. These platforms provide intelligence and surveillance data to conduct maritime operations.

Under the Air Surveillance, Sri Lankan Air Force consists of Beach Crafts and Unmanned Aerial Vehicles (UAV's) for air reconnaissance. (Exact numbers are not mentioned) (Airforce, 2016) The existing maritime intelligence and surveillance capabilities are rarely available in open sources. If summarized naval sea platforms (Ships and Craft) are the main intelligence gathering methods. Other than that coastal Radar, Sonar, GPS, AIS, VMS, human intelligence, communication intelligence and electronic intelligences methods are used to collect data. Satellite technology is rarely used to gather maritime data, since it is highly expensive.

### D Cooperative security mechanism

This will concentrate more on intrastate relationship and cooperative security mechanism of military to military and military to civil security components. The Co-operative Security was developed and deeply practiced after the 9/11 attack to the USA. It was one of the major turning points in the world where the entire gamut of security was changed. Cooperative security is defined as states working together to deal with non-state threats" (Mihalka, 2005, p.113). This article further highlighted that, with the rise of globalization, cooperative security is a peak requirement to counter transnational security issues in the world.

When it is considered in the Sri Lankan context, transnational maritime security threats and challenges are infiltrating the country. These threats and challenges cannot be countered by being on our own. In view of the broader nature of these security issues, countering mechanism should be a combined effort. Therefore, domestic co-operative security mechanism is of vital importance to the national requirement today. This can be achieved by the combination of civil and military maritime

security components. When countering maritime threats to the country such as human smuggling, drug trafficking, gun running, there are numbers of maritime stakeholders who are engaged in these operations; such as Navy, Coast Guard, Narcotic bureau, Custom, Department of Fisheries and Immigration and Emigration. Since the threats are common to the entire stakeholders countering mechanism must be a combined one to make it more successful.

When the Philippine Coastal Watch System (CWS), is considered it is the inter agency effort of countering non-traditional security threats to the country that helps its smooth running.

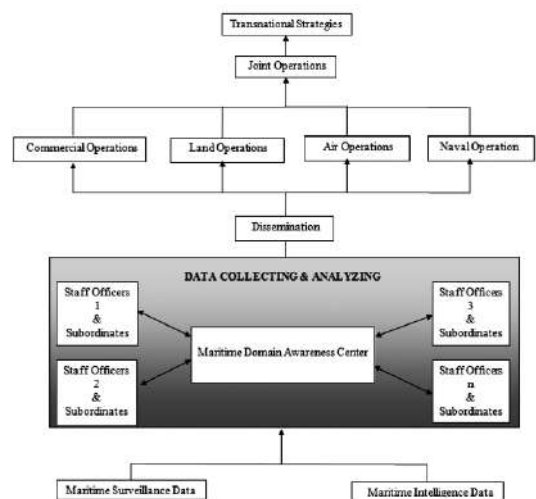
“The key functions of the initiative are to develop a common operating picture of the maritime domain in the Philippines, to collect, consolidate, and integrate all data relevant to maritime security and to provide real-time information for the purposes of cueing, locating, interdicting, apprehending, and prosecuting those who engage in illegal maritime activities” (Rabasa & Chalk, 2012, p.21). The whole system is co-ordinated by Maritime Research Information Center situated in Manila. This system is supported by Australia and USA. Philippine long-term aim is to link the CWS with similar initiatives in Malaysia and Indonesia to create a sub-regional regime of MDA. Therefore, it is a timely requirement of Sri Lanka Navy to take an initiative to establish a MDA center to establish inter agency support to counter non-traditional security threats to the country.

Information and surveillance data gathering from various sources of maritime affiliates need to centre in to a mini ‘Maritime Domain Awareness Centre’.

- The gathered information is required to analyse via staff officers of different security components. (Working Staff of the centre need to represent each security component such as Navy, Army, Air force, Coast guard, Custom, Immigration and Emigration, Department of fisheries etc.)
- The staff officers are required to share the information and data among security affiliates and take decisions quickly and with precision, which would enable to have a common operational picture.
- Processed intelligence must be prioritized according to threat axis to the country and disseminate in to the relevant authority. According to the intelligence reports naval and commercial operations can be implemented.

(To establish Sea Power around island) Further gathered intelligence is required to forward to strategic level decision

- Strategies adopted in combination of operational level decision making is essential.( Discussion of lapses in coastal security arrangement architecture such as modern surveillance equipment’s, Maritime Patrol Air Craft (MPAC), Offshore Patrol Vessels) OPV, Fishing boats-commercial operations, etc).
- Following structure is of a mini MDA centre which has been identified and recommended to implement in the future.



**Figure 1: Maritime Domain Awareness Center (Developed by the author)**

According to figure 1, maritime intelligence and surveillance data collected from different sources are gathered in to mini MDA centre. Maritime Shareholders will be analyse the data and disseminate in to relevant civil and military security agencies to conduct their operation. This may be a single or joint operation. The collective effort of this centre could find transnational counter strategies to transnational threats and challenges

#### IV. CONCLUSION

The comprehensive understanding of Maritime Domain Awareness and Co-operative Security are very important in the field of maritime warfare. The conceptual

understanding of these theories is the key success for the practical usage of maritime operations. The identification of possible traditional and non-traditional security issues to Sri Lanka at a precise time is of vital importance to create policies by the strategic level decision makers. Naval warfare is an art and deep study of military strategies by practitioners is one of the important factors for the maritime security to the country. Military and civil maritime capabilities of Sri Lankan maritime security components are the outer most layer of defence which will provide security by safe guarding maritime environment. Effective collaboration among maritime affiliates is essential to progress with this momentum.

The existing maritime security structure in Sri Lanka lacks the proper mechanism for intelligence and surveillance sharing location. The significance of naval contribution to strengthen the maritime security of Sri Lanka clearly needs to be identified by the maritime stakeholders. The objective of this paper is to emphasize the necessity of formulating a mini 'Maritime Domain Awareness Centre'.

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## ABBREVIATIONS

Coastal Watch System	- CWS
Illegal Unreported and Unregulated fishing	- IUU fishing
Liberation Tigers of Tamil Eelam	- LTTE
Maritime Domain Awareness	- MDA
Maritime Patrol Air Craft	- MPAC
Offshore Patrol Vessels	- OPV
Unmanned Aerial Vehicle	- UAV

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# STRATEGIC IMPORTANCE OF BLUE ECONOMY TO SRI LANKA AND CHALLENGES

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**Abstract** - At the COP+21 conference, the idea of blue energy and blue economy first emerged as a component of green economy. At a time when the world is moving away from the Millennium goals towards a Sustainable Development, the emergence of sustainable blue economy seems vital. Blue economy is the sustainable use of marine resources for economic purposes. It generates an economy through the usage of marine and oceanic resources. National policies have also shifted for a greener aspect with an intention to promote a sustainable balance between economic growth and ocean health.

Sri Lanka, an island strategically positioned in the Indian Ocean amidst major commercial trade routes encompasses a sea area which is seven times larger than its land area. Having the geographical and territorial advantage, its potential in Blue economy is immense given accurate implication and strategic planning. Rising from the ashes of a thirty-year civil war, the country struggles to strengthen its economy while fostering the rehabilitation and reconciliation processes. The true potential of the nation is hindered by various state and extra territorial non-state actors. This paper intends to address potential of blue economy in the changing global challenges, strategic advantages and national prospects.

**Keywords** - Blue Economy, Sustainable Development Goals, Human Security

## I. INTRODUCTION

Oceans cover more than 72% of the Earth's surface and constitute more than 92% of the biosphere. Oceans contribute to the main lifeline of the human kind, generating oxygen, absorbing Carbon dioxide, recycling nutrients, and regulating global climate change and

temperature. Oceans are also the means of transport for 80% of the Global Trade and also the main source of protein for the world community. At the Rio +20, United Nations Conference on Sustainable Development, where the main theme was Green Economy and the advancement and development of Institutional framework for Sustainable Development, a concept of a Blue Economy emerged due to the concerns raised prior to the conference by the coastal countries. Thus Rio+20 marks the first instance where the phenomena of 'Blue Economy' was raised in an International platform.

The ideology behind the concept was that Oceans, being the common heritage of the human kind, represent the man's quest for sustainable development. Since Rio +20, there has been combined and Institutional effort to develop and expand Blue Economy, and its importance was reflected, when protection of seas was recognised by the United Nations Resolution as a priority objective of its Sustainable Development Goals, Agenda 2030.

The seabed provides for 32% of the global supply of hydrocarbons and contributes to the global tourism industry. However, only 5 to 7% of the Ocean is yet explored, thus the potential for expansion and development is vast. Advancing technologies open up opportunity from bio-prospecting of the Ocean to mining of the seabed mineral resources, extracting of oil and other bio gases and other renewable 'blue energy' sources like wind, tidal, thermal and biomass.

Human Development activities and global challenges like climate change, global warming, melting of glaciers have started to exhaust the resources that are available for human consumption. It is known that we have already used up all the land based resources due to the 'Brown



Economy' concept and are facing the consequences. The days where the Oceans were used for resource extraction and waste dumping has left the world with severe penalties. The world collectively must look forward to the future and use resources sustainably, which is the Global objective since 2015.

Since Ocean remains the major natural resource in the world that is yet to be fully consumed and explored, it is crucial that each State, Institutions, Human beings individually and collectively take initiatives to use the resources in a sustainable manner. The prospective for Oceans to meet the goals of sustainable development is immense, given it can be maintained and restored to a healthy state. Thus Oceans are becoming a major focal point in the growth and sustainable development, both domestically and internationally. With the economic priorities are expected to be based on Ocean, the challenge is how the seas are maintained to facilitate the ocean health and long term benefits of the ocean ecosystems.

Sri Lanka, a small Island nation in the middle of the Indian Ocean consists of a sea territory which is 7 times larger than its land area. While Sri Lanka does not belong to the category of Small Island Developing States (SIDS) which concentrates on Blue Economy and upon which the principles are developed on, it is necessary that we take sustainable ocean economic measures for the goodwill of the future of the country. Strategically located amidst the Western Indian Ocean and the South East Indian Ocean, and having no immediate territorial neighbour apart from India on its North, Sri Lanka has a vast if not the most potential for Blue Economy in the South Asia.

Global Challenges like climate change, global warming, melting of the glaciers, growing global population, poverty and food security and healthcare are inevitable phenomena which everyone has to counter. Acceptance of the realities of the changing global circumstances will give an insight into the need for the protection of the resource scarcity and thus the sustainable use of the resources and energy for the future consumption as well.

'The Great Acceleration', the plunge of economic and industrial activity in the last 20th century has led to harsh consequences in the ocean ecosystems. Therefore, countering the global ocean health challenge is a matter of urgency.

With the growing population and the resource crunch thereto, Sri Lanka must take measures to move away and put a halt to its harmful oceanic practices like waste

dumping, unauthorised fishing practices and non-eco-friendly tourism to address the global challenges of climate change and global warming. It is necessary that Blue Economy initiatives are taken, however small, for it is already accepted that Oceans are the future of the Earth, and therefore to ensure human security.

This paper intends to draw an analysis of the concept of Blue Economy and speak of its components and applicability to Sri Lanka. It will look at the application of Blue Economy by Island nations like Seychelles and Mauritius and its efficiency. The paper will speak of the Sri Lanka's position in Ocean economy, its true potential and the current practices and of how policy initiatives can be taken to adopt a sustainable ocean/ marine policy to uphold Blue Economy. The paper also intends to look at the issues and challenges Sri Lanka as a country must overcome in order to lay out an efficient and a practical Blue Economy Strategy.

## II. METHODOLOGY

Blue Economy is a fairly new concept, having first spoken of in 2012 and developed thereafter in 2014 onwards with its applicability in the Sustainable Development Goals. Therefore, not many literature is available on the subject, however several analysis and concept papers are published by various International and Independent Organisations as well as Non-Governmental Organisations.

The methodology of the paper is therefore a qualitative one, based mainly on resources available online and white papers of Governments working on Blue Economy. It should be noted how a great comparison and an analytical deciphering of the available resources is not possible due to lack of a time frame for the outcome and efficiency of the policies. Apart from the online resources, an interview was conducted with Admiral (ret'd) Dr. Jayanath Colombage who helped the author immensely in understanding the concept, its relevancy to World and Sri Lanka and for providing with reading material on the subject for a greater understanding.

## III. DISCUSSION AND RESULTS

### A. Defining Blue Economy

Blue Economy in its simplest form would mean the sustainable development of ocean economy. Some would also call it the 'greening of the ocean economy' since the

concept originated from the broader Green Economy concept and with the awareness of destruction brought upon by the ocean ecosystems by human activity. Blue economy, blue growth, sustainable ocean economy are all terms that came into the existence in the very recent past and remains ill-defined giving ample of room for wide interpretations.

The European Commission defines Blue Economy as “all economic activities related to the oceans, seas and coasts. This includes the closest direct and indirect supporting activities necessary for the functioning of these economic sectors, which can be located anywhere, including landlocked countries” (European Commission, 2012).

According to The Economist Intelligence Unit, ‘A Sustainable ocean economy emerges when economic activity is in balance with the long-term capacity of ocean ecosystems to support this activity and remain resilient and healthy’ (Economist & Unit, 2015). The Governments, NGOs and others look at the broader view of blue economy and seek to strike a balance between economic growth and ocean health. Though blue economy is used as a guiding principle in national development strategies, it is up to the policy makers to fill the gaps. While developing ocean economic practices is upfront, what amount to sustainable ocean economic measures remain uncertain. States must take measures to adapt blue economy to its resources and within their Exclusive Economic Zone.

The Australian government defines Blue Economy as “... one in which our ecosystems bring economic and social benefits that are essential, equitable and sustainable” (Govt. of Australia, 2013).

The contribution of ocean economy into one’s overall economy is generally underrated. In 2014, 10% of China’s GDP was from Ocean economy (Zhao, et al., January 2014), whereas in Indonesia, it adds up to about 20%, a similar ratio to other low-middle-income countries with large ocean territories (Economist & Unit, 2015). However, obtaining exact statistics is hard for there is only a very fine line between coastal and oceanic economy.

Blue Economy though misinterpreted as a synonym for ocean, marine and coastal economy, encompasses all three within its ambit as well as other ocean based and ocean related economies. Thus, the scope of blue economy is very vast and given the unaccounted and undiscovered resources, the potential is very large.

United Nations conceptualises Oceans as ‘Development Spaces’ where spatial planning integrates conservation, sustainable use, oil and mineral wealth extraction, bio prospecting, sustainable energy production and marine transport. The Blue Economy initiative also aspires the same desired outcome as the Rio +20 Green Economy movement, namely “improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities” and intends to uphold the principles of “Low Carbon, resource efficiency and social inclusion”. This means a departure from the existing ‘brown’ model of development which does not take into account the ecological factor.

Therefore, it is necessary that a comprehensive definition is adopted by nations according to ones’ suitability and needs.

## **B. Potential of Blue Economy**

The concept covers a wide range of activities which can be identified by their geographical locations and sectors and specializations. The potential of blue economy ranges from fisheries and aquaculture to renewable ocean energy to marine biotechnology to tourism and coastal management.

Being a ‘common’ global resource, blue economy should be promoted through regional cooperation. A draft paper by the Indian Ocean Rim Association Secretariat identified eight priority areas for regional cooperation in Blue Economy. Economies have identified that the fates of their economies and health of the planet is linked with the health of the ocean. The region is dependent on the Ocean for critical issues including food security, mineral and energy security, habitat security, industrial activities and other services which ultimately leads to the main objective of ensuring human security.

**Table 1: Taxonomy of Blue Economy Sectors and Activities**

<b>SECTOR</b>	<b>ACTIVITY</b>
Fishing	Capture fishery, aquaculture, seafood processing
Marine Biotechnology	Pharmaceuticals, chemicals, seaweed harvesting, seafood products, marine derived bio-products
Minerals	Oil and gas, deep-sea mining, exploration of the rare earth metals and hydrocarbons)
Marine Renewable Energy	Offshore wind energy production, wave energy production, tidal energy production
Marine manufacturing	Boat manufacturing, sail making, net manufacturing, boat and ship repair, marine instrumentation, aquaculture technology, water construction, marine industrial engineering
Shipping, Port and Maritime Logistics	Ship building and repairing, ship owners and operations, shipping agents and brokers, ship management, liner and port agents, port companies, ship suppliers, container shipping services, stevedores, roll-on roll-off operations, custom clearance, freight forwarders, safety and training
Marine Tourism and Leisure	Sea angling from boats, sea angling from the shore, sailing at sea, boating at sea, water skiing, jet skiing, surfing, sail boarding, sea kayaking, scuba diving, swimming in the sea, bird watching in coastal areas, whale/dolphin watching, visiting coastal natural reserves, trips to the beach, seaside and islands
Marine Construction	Marine construction and engineering
Marine Commerce	Marine financial services, marine legal services, marine insurances, ship finances and related services, charterers, media and publishing
Marine ICT	Marine engineering consultancy, meteorological consultancy, environmental consultancy, hydro-survey consultancy, project management consultancy, ICT solutions, geo-informatics services, yacht design, submarine telecom,
Education and Research	Education and training, R & D

*Source; (Mohanty, et al., 2015)*

**C. Case of Sri Lanka; Potential and Prospects**

Sri Lanka, a small island nation in the Indian Ocean shares a very intimate, strong and a historical bond with water. Among the 103 rivers flowing through the country, 90% of the land area is covered by the river basins (Azmy, 2011). The Maritime Zone Law No 22 of 1976 provide for the national jurisdiction of the territorial seas and maritime zones of Sri Lanka. Accordingly, the ‘Exclusive Economic Zone’ extend to a distance of 200 nautical miles from the baseline which amounts to about 517,000 km<sup>2</sup> in extent, i.e. 7.8 times the total area of the land. Sri Lanka’s coastal

area which constitutes of an area lying within the limit of 300m landwards of the Mean High Water line and a limit of 2km seawards of the Mean Low Water line covers up to 14 administrative districts which is approximately 23% of the total land area of the country (Azmy, 2011). The coastal area of the country is thus home to 25% of Sri Lanka’s population. Therefore, as a country where ¼ of the population rely on coastal and oceanic based activities, Sri Lanka must take serious measures to ensure the marine resources are used sustainably to secure the future generations and meet the universal goals.

Fish serve as the main source of protein in Sri Lanka amounting to 70% of the total animal protein share (Food and Agriculture Organization, 2014). In order to meet the demands of adequate and sustainable supply of fish, sustainable fishery methods like freshwater farming and mari-culture should be encouraged, and thereby managing the food security situation. The illegal and unhealthy fishing practices like using unauthorised fishing gear and using explosives to increase the fishing yield disturb the marine eco system which has long term effects on the regional marine resources. The lack of data and transparency in fishing activities and management also make the sustainable fisheries management in the region difficult.

#### D. Issues and Challenges

It is necessary that in order to move ahead with the sustainable Oceanic activity, there must be effective regional cooperation as the goal is to prevent a tragedy of commons. It is also vital that the challenges and issues are identifies and addressed to. Sri Lanka's on going conflict with India over the International Maritime Boundary Line Palk Bay and Gulf of Mannar prevents the two countries from identifying common goals of blue economy. The unhealthy practice of bottom trawling by the Indian fishermen cause severe harm to the marine eco-system (Goonetilleke & Colombage, 2017).

Sri Lankan waters have also become a transit hub for narcotic drugs and humans with the help of the fishermen. Lack of regulation and immigration practices on the fishermen make the task easier for the traffickers who carry out illegal business and transactions on the sea areas of Sri Lanka (Dissanayake, 2015). The fishing boats are also susceptible for exploitation by the terrorist group as it did during the civil war.

Apart from the above, at the 7th International Maritime Conference Admiral Dr. Jayanath Colombage identified several threats of sustenance of fisheries resources which range from deliberate destructive practices to accidental ones. These include, accidental oil leakages and release of gases during storage, shipping and overfishing which cause serious harm to the marine eco-system and the life thereof. Shipping though considered the most carbon efficient mode of transportation, emit greenhouse gases and cause acoustic pollution through hazardous waste which remain intact in oceans for long periods and thereby affecting the natural course of the food chain.

Developing sustainable coastal tourism is beneficial in blue economy. In 2015, 8.5% of the world tourism industry amounting to US\$ 670 billion was form the IORA region (Mohanty, et al., 2015). Water based tourism and leisure based activities which foster smart sustainable and inclusive growth should be implemented. Sri Lanka currently has a wide array of leisure and please activities based on coastal areas but the endurance of the same is questionable. For example, whale watching in the North Western and Southern provinces of the country has gained much popularity over the recent years. However, it is observed that the boats get extremely close to the whales which disrupt their natural modes of communication by waves and hence their behavioural pattern which may have long term implications like coastal erosion, mangrove depletion and threaten to fish, wildlife and habitat. Land based Aquaculture projects result in habitat destruction through release of poisonous chemicals and drugs (Spalding, 2016).

All the above mentioned challenges and issues are intensified by the global challenge of climate change and global warming. With the excessive release of greenhouse gases and the increase in the surface temperature lead to melting of the glaciers thereby raising the sea level. Along with the rising sea levels, the changes in the sea temperature would directly affect the ocean acidification and the aquatic cycles. Climate change causing a rise in sea surface temperature, salinity, ocean acidification and thermal stress affect the fisheries distribution, migration and thus a break in the marine eco-cycle. These natural phenomena along with overexploitation and pollution dismay the fisheries industry. Rising of sea levels eventually lead to the depletion of the coastal area of the land thereby affecting more than 25% of the Sri Lankan population. With an annual population growth rate of 0.9% (Central Bank of Sri Lanka, 2015), the pressure on the land based resources increase exponentially and the strain only intensifies with the reduction of land area due to rising sea levels. The human security of the coastal community is greatly affected with them having no social, economic or food security. If the prolonging security issues are not addressed, there is a risk of the coastal community being hurled into illegal oceanic activities like piracy and trafficking.

#### E. Way Forward

In order to meet the objectives of goal 14 of sustainable development goals for the 2030 agenda, the country must adopt measures that are most efficient, sustainable and suitable for the country. For an effective plan to

take action, there must first be a national maritime policy. Lack of a national policy and therefore a national strategy to deal with ocean can lead to the inefficiency and unaccountability of the authorities paving way for more misapprehensions of the process. When adopting a national blue economy policy, Sri Lanka could look at Mauritius and Seychelles who have successfully adopted blue economy as 'small island developing states' (SIDS) in the region. Though Sri Lanka does not come within the ambit of SIDS, their practices on fishing industry and tourism can be adopted.

While focussing on policy and national strategy on blue economy, it is necessary that the existing oceanic activities are revised and accustomed to sustainable, efficient measures. Colombo as one of the busiest ports in the region can recommend Triple E class (Economy of scale, Energy efficient and environmentally friendly) vessels to come into operation. More than 2/3rd of global seaborne trade are routed through Indian Ocean and Sri Lanka's geostrategic location gives immense potential for the port and shipping services. By imposing more systematic, target oriented and futuristic policies and regulations the services can be enriched.

The flora and fauna of the Indian Ocean provide the biggest opportunities for the tourist investment in the region but it is necessary that all activities are monitored to optimization. Coastal tourism amounts to 70% of the total tourism infrastructure in the country. Coastal tourism can be expanded to new heights, but there must be regulations in place to manage the activities and control the quality of the service. It must always be kept in mind that the activities should not disturb the development of natural marine-cycle or break apart the habitat. Coastal management should be a major component of the Sri Lankan blue economic policy.

According to International Energy Agency, the global primary energy demand would increase by 40% by 2030 and Asia and Middle East are predicted to be major contributors (IEA, 2015). Wave, solar, wind, hydroelectric energy can all be generated with the available resources in the country. We just need the proper research, development and implementation. Experiencing 2 monsoons throughout the year, Sri Lanka has great potential for tidal and wave energy along South-West and North-West coasts.

Most of the aquaculture industries which are land based carry out their functions without licence. The authorities must pass policies to address the small matters like

licenses and the safety and hygiene measures. The unauthorised practices must be regulated and the owners and practitioners must be screened. All the regulations must ensure that the marine eco system is not harmed and the resources can be used by future generations.

While improving the existing measures and adopting sustainable measures, the country must invest in research and development. Since blue economy is a new concept, research is much needed. In order to bring marine biotechnology or marine technology, the technological know-how must be brought into the country.

## IV. CONCLUSION

As a strategically located island in the Indian Ocean with an ocean territory which is 7.8 times larger than its land area, Sri Lanka must know how to systematically and skilfully use its marine resources to economically sound the country. In doing so, the island must also ensure that the global objectives of sustainable development are met. It is the belief of many scientists, philosophers, strategists and economists that the future is going to be the 'era of the ocean'. With climate change and global warming shaping up the immediate futures, States must take action to prevent natural resources for the betterment of the future generations and thus consuming the existing resources sustainably.

Goal 14 of the Sustainable Development Goals, Agenda 2030 identifies the importance of 'life under water'. With this, the concept of 'blue economy', which was first conceptualised in Rio +20 conference, was given much prominence to and was taken more seriously. The objective was to develop and adopt sustainable oceanic economic measures. Though developed by Small Island Developing States, blue economic policies are much relevant to Sri Lanka as well. This paper intended to give a brief understanding of the concept of blue economy, its scope and its applicability to Sri Lanka. It identified the drawbacks of the existing marine related industries and how they can be amended to efficient and sustainable measures. The fisheries industry, aquaculture industry, shipping, coastal management and tourism sectors which are exploited by various actors and authorities were looked at and recommendations for each were given.

What is important to note is that, ocean is a 'common good' and thus all humankind carry a responsibility to protect it for the future. In order to prevent a 'tragedy of commons', it is necessary to take necessary actions.

Sri Lanka though a member of the IORA, has not taken any initiative on the national level to address the global challenge of climate change. As a country whose 25% of population depends on coastal economy, Sri Lanka must ideally take effective policy measures and initiatives to uphold blue economy. The advantageous location and circumstances must be used tactfully to economically enhance the country. Lack of interest, knowledge, awareness, differing priorities have so far prevented any government or authority from taking any initiative.

With Sri Lanka's marine territory, the willing and able coastal population, the nation must take steps of combatting global warming and climate change at the initial stages i.e. now rather than finding fixer uppers when tragedy strikes.

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# BOTTOM TRAWLING IN PALK BAY AREA: HUMAN AND ENVIRONMENTAL IMPLICATIONS

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**Abstract-** Sri Lanka is an island positioned in a geo strategically decisive point in the Indian Ocean. Palk bay is a shallow and narrow strip of water between Sri Lanka and Tamil Nadu, Palk Bay has a rich ecosystem which is being progressive environmental attenuation due to bottom trawling. Elimination of bottom trawling in fishing is needed to save that rich ecosystem in Palk bay. It is important to suggest environmental healthy fishing practices and to inspire the dependent families of bottom trawling to enter into substitute job opportunities. Bottom trawling leads to many problems in whole ecological structure and life below water. Since a large number of people in Sri Lanka are committed in this fishing practice, this directly affects moreover the whole Sri Lankan Northern livelihood. This research will debate on seriousness of banning bottom trawling and explore lasting solutions that would aid environment as well as livelihood of people in Sri Lanka. The research design to be carried out by analysing existing literature subjective to qualitative analysis. Empirical studies carried out by the statistics and data published by recognized institutions. Qualitative data would be collected from individuals such as academics and policy makers. Data collection would be semi-structured interviews done informally.

**Keywords** - Geo-Strategy, Bottom Trawling, Ecosystem, Marine life, Environment

## I. INTRODUCTION

India and Sri Lanka are parted by the Palk bay and the Gulf of Mannar. According to the statistics nearly 2000 plus trawlers fish illegally in Sri Lankan waters daily (Sunday observer, 2017). Those fishermen practice illegal methods

which are regarded to be unhealthy and it constitutes extensive aquatic species. The series of problems arise from this unhealthy fishing process which makes it hard to achieve true sustainable development goals, such as eliminate poverty and sustainable managing and conserve the life below water.

There are three different areas in the Maritime border between the two countries which is about 400 kilometers widening. They are, the Bay of Bengal in the north, the Palk

Bay and the Gulf of Mannar in the center and the Indian Ocean in the south. The distance in Palk Bay region varies

between 16 and 45 kms between the coasts of the two countries. This means territorial waters of each country in some areas departs into the others if 12 nautical mile criteria is rigorously applied. Mechanized bottom trawling is dragging weighted nets along the ocean floor. It is designed to catch large quantities of marine life. Bottom trawling irreversibly wipe out marine habitats. The Marine Conservation institute has attended that bottom trawling is reckless because trawlers customarily throw overboard up to 90 per cent of the catch. Statistics states that over a thousand Indian boats enlist in mechanized bottom trawling every week in Sri Lankan waters. Due to that Sri Lankan fishermen are being interrupted from accessing these waters and engaging in their livelihood. The Indian trawlers drain a large sum of fishing resources leaving a very limited extent for Sri Lankan fishermen to catch. Trespassing Indian trawlers were seized by the Sri Lankan government but it has affected the goodwill between Sri Lankan and Indian diplomatic relationships. Limited bans on bottom trawling bans has been imposed by some

countries like Chile, Indonesia, New Zealand and United States. Similarly Indian states, Tamil Nadu and Kerala impose annual fishing bans to blunt the devastating effects of the practice. Therefore it is clear that bottom trawling practice is a careless form of fishing which shatters the environment and livelihoods of Sri Lankan fishermen. The United Nations Development Summit in September 2015, endorse the UN Resolution 70/1, “Transforming our world: The 2030 Agenda for Sustainable Development”. The objective of this was the compassionate that global resources in the oceans should be delicately handled for a sustainable future, as the oceans are key in accomplishing the earth habitable for humankind. The main objective of Goal 14 of this agenda, ‘Life below Water’ is to “conserve and sustainably use oceans, seas and marine resources for sustainable development” (UN, 2015).

The spirit of this resolution is clearly applicable to the Indo-Sri Lanka fishery conflict. The UN has set a target year, 2020, to end Illegal, Unreported and Unregulated (IUU) fishing. The UN resolution also talks about conservation and sustainable use of oceans as per international law as reflected in UNCLOS, and encouraging sustainable artisan fishing. India and Sri Lanka being member states of the UN should abide by this resolution.

## II. INDIA –SRI LANKA BANNED BOTTOM TRAWLING

The expanding conflict in distribution of the fishing grounds and fishery resources of Palk Bay by the Indian and Sri Lankan fishers is a continual dilemma for both the governments of these two countries. The stocks of fishery resources in Palk Bay has been shrink by unhealthy fishing practices, which also causes a progressive degradation of the eco system (Daily News, 2017)

For long period of time both these Indian and Sri Lankan fishermen have been fishing into Palk Bay area. The complications looms only after a maritime agreement was signed by India and Sri Lanka in 1974. In 1974, a maritime agreement between India and Sri Lanka was demarcated. The jurisdiction over Kachchatheevu Islands was handed over to Sri Lanka. These rich resource full islands are located on the eastern side of India’s maritime boundary with Sri Lanka.

The maritime boundary agreements of 1974 and 1976— which delimited international boarder in the name of good neighborly relations in the Palk Bay and the Gulf of

Mannar and Bay of Bengal, respectively achieved by the two governments, but they did not call in with fishermen so this agreement found to be hard to follow realities on the ground. The foundation of national sovereignty underpinned both agreements. The foreign minister, Sawaran Singh, once said, though the island was ceded to Sri Lanka, the Indian fishermen continued to enjoy their traditional rights of fishing in and around Kachchatheevu and also participated in the Saint Anthony’s festival (held annually at the end of March) without obtaining visas. This allegation aside, those opposing the decision later states that the traditional rights of fishing were hampered by the 1976 boundary agreement.

Tamil fishermen from Tamil Nadu consider that Katchatheevu is routinely their terrain. They believe that they have a right to fish there. That threaten the livelihood of Sri Lankan fishermen. The direction seems to have cut worse after the Fourth Eelam War in 2009. The ongoing dispute has escalated tensions between those fishermen using traditional methods and those using mechanized methods, as well as increased the infringement of territorial boundaries. Fueling the dispute over Kachchatheevu are the overuse of mechanized trawlers in the Palk Bay, the damaging environmental and economic effects of trawling, and the detention of fishermen. To increase productivity and boost exports, the government of India embarked on a radical transformation of fishing techniques. The result was the introduction of trawlers. A severe side effect has been the untold damage to marine ecology and, specifically, fish stocks.

In a latest incident, the Sri Lankan Navy allegedly fired at a group of Indian fishermen who had allegedly crossed over into Sri Lankan waters on the lookout for fresh catch. One fisherman was killed in the incident and three others were injured. The Sri Lankans opened fire on the fishermen who were apparently fishing off the coast of Tamil Nadu between Dhanushkodi and Katchatheevu.





**Figure 1**  
*Coastal Area between Katchchatheevu and North Sri Lanka*

The bilateral agreements between Sri Lanka and India agreed as soon as possible to banned bottom trawling by south Indian fishermen in the Sri Lanka's territorial waters. Currently between 1500 – 2000 trawlers are known to be poaching in Sri Lanka's territorial waters using bottom trawling method. Bottom trawling is banned in India and Sri Lanka urged the Indian officials to ban South Indian Fishermen from poaching in our territorial waters using the illegal method of bottom trawling. Sri Lanka emphasized the fact that it needs to be sustainable solution for this long term issue which time to time strained the relationship between Sri Lanka and India. Sri Lanka has not yet banned bottom trawling in coastal waters, although the practice is banned in inland waters. India knows that the use of trawlers by its fishermen is fueling the conflict. It agreed with Sri Lanka on "expediting the transition towards ending the practice of bottom trawling at the earliest". But in the absence of an early time frame within which this would be achieved, its commitment to finding a solution to the conflict appears weak.



**Figure 2**  
*Environmental Implications*

Bottom Trawling fishing methods have both direct and indirect impacts on the marine ecosystem as well as on biodiversity, as this methods of fishing collect and kill huge amount of non-targeted species and premature ones of commercially valuable species which, mechanically interrupts the bottom of the sea and oppresses a wide variety of marine benthic creatures. The major problems recognized are the environmental impact by the bottom trawling to the whole ecological structure living below water and the political issues generating from this fishing practice in the Palk Bay which is prone to cross-fire regarding the geopolitics and strategic relations between the two states.

These trawlers are not only engaged in fishing but also in other activities which threaten the security of the region and this issue has a considerable impact on the security of the regional waters. The method of bottom trawling practiced in Northern waters is "benthic trawling" which is dragging a net at the very bottom of the ocean. This huge net captures everything in their path including corral unwanted fish which is called "by catch" that is thrown back to the sea dead or dying after the net is taken out. It destroys centuries old coral reefs habitats that are important to the ecosystem. Sources depicted that in bottom trawling, a fishing net known as a trawl is towed along the sea bed at the bottom of the ocean targeting bottom living fish especially the prawns, destroying even the sea weeds and corals in the process. As trawling removes colossal amounts of high biomass organisms in the sea bed, represent mainly by emergent organisms, productivity of the seabed will be affected considerably.

Further, sea-bed organisms help in increasing the sea-bed complexity, which offers shelter for young organisms and thus reduces their vulnerability to predation. Benthic communities play an important role in remineralizing and release of nutrients in marine eco systems. The practice removes most species from its path, homogenizes habitat and reduces complexity. It has been shown to reduce species diversity and create disturbances that can lead to dominance by detrimental predatory scavenger species. Deep sea corals and other species tend to be long-lived and slow-growing, with some having been dated at 5,000–8,000 years old. A single pass of heavy trawling equipment can destroy such benthic structures. Under the United Nations' Law of the Sea (UNCLOS), responsibility for the management of marine living resources differs according to its location. Coastal states have the responsibility to explore, exploit, conserve and manage the living resources found in the water column within their exclusive economic zones (EEZs), out to 200 nm from their coastal baselines.

They also have sovereign rights to explore and exploit resources, including sedentary living species, on and within their continental shelves past 200 nm, out to 350nm. Under UNCLOS, all states have the right to fish on the high seas – the 64% of the oceans outside of EEZs, although this 'freedom' is constrained by equivalent obligations to cooperate to ensure the conservation and management of living marine resources and to protect and preserve the marine environment. More recent agreements have further elaborated fishers' opportunities and obligations, the most notable being the 1995 UN Fish Stocks Agreement. Regional fisheries management organizations (RFMOs) have been established to allow interested states to collaboratively manage highly migratory and straddling fish stocks. Recently taken Radar pictures prove large scale Indian fishing operations very close to Sri Lanka's coast line and islands using destructive 'bottom trawling' which is illegal in Sri Lanka as well as in India, causing immense damage to the sea bed.

### A. Human Livelihood Implications

Sri Lankan fishermen are often forced to stay ashore for fear that these trawlers will damage their nets, their primary assets for livelihood. There have even been incidents of fishermen suffering physical injuries while attempting to save their nets from being damaged by Indian trawlers. Nearly 200,000 people in the Northern Province are dependent from the fisheries sector. Moreover a large number on the tourism sector have undergone many sufferings due to the civil war, most importantly

they have lost their employment opportunities. Most of these individuals do not possess special skills to find employments in other fields bottom trawling have a direct impact on their economic livelihood. Most of the people are engaged in this fishing practice therefore effects to bottom trawling will affect the livelihood of them and their families. Furthermore the impact of this to the whole Sri Lankan Northern livelihood and economy of Sri Lanka also enormous.

There are hundreds of ships and boats laying on the sea bed on Northern Sea since 70's and 80's centuries and these are homes for millions of marine species. Moreover it is a destination for tourists from developed countries who are interested in adventures activities and also who are studying about those species and their history. Bottom trawling completely destroys all these to a point where it become irrecoverable. However, it is clear that almost all who are engaged in bottom trawling, are contracted employees. It is alleged, the trawlers are owned by large-scale businessmen, often close to the political elite of the state. Prawns have become a multimillion-dollar industry; mainly for exporting to the USA, Japan and Western Europe. However, when the Sri Lankan authorities arrest these Indian trawlers for poaching in its territorial waters, and subject offenders to judicial processes, there are huge protests in Tamil Nadu and letters written to the central government demanding intervention.

It is clear that, almost all persons, who are engaged in bottom trawling, are contracted employees. It is noted that the trawlers are actually owned by large-scale businessmen, who are often close to the political elite of the state. As a result of that numerous fishermen became daily wage labourers. This will lead to increase number of trawlers in the three South Indian districts of the Palk Bay. All these trawlers are engage in bottom trawling in Sri Lanka Waters.

## III RECOMMENDATIONS

We suggested to educate Indian people who are engaged in this unhealthy environmental destroying bottom trawling practices about the environmental healthy fishing practices and introduce them new environmental healthy fishing practices with means and methods of fishing at a low cost using easy techniques. Most importantly the two states shall encounter with negotiations in order to eliminate illegal poaching which is a threat to the economy of Sri Lanka. There are so many people who are

self-employed in handy craft industry and other related sectors providing services for the tourists (specially) women headed families. Provide alternative livelihood for fishermen engaged in trawling and to construct tuna long liners. Through incentives and persuasion, affected fishermen could be encouraged to switch over to deep sea fishing or engage in other vocations. Banning the practice of bottom trawling will also greatly reduce the incentive to trespass into Sri Lankan waters.

Many an academic and political point is that this bottom trawling problem cannot be solved. It is clear that this problem concerning the Indo – Lanka maritime issues be given far more concern and focus than it is now by the government of Sri Lanka as well as researchers to come up with a research studies to identify solutions so that there may be areas untouched which might bring about a lasting solution. To have more and more academics and policy makers to think about this problem with a view for a solution.

The government of Sri Lanka to focus on negotiated settlement with the Central Government of India through diplomacy and international relations, so that a settlement could be solved taking into consideration the UNCLOS III – a legal framework and to come upon an agreement or a bill where both states will work towards banning bottom trawling. Sri Lanka's concern is whether the precious marine ecosystem in the Palk Bay would survive until these measures are implemented. There is a need for scientific research on the subject, to ascertain the real damage caused by bottom trawling and the impact on the fisheries in the Palk Bay, gather data from primary and secondary sources, make an assessment of the cost of annual losses due to poaching, and be ready to present an incontrovertible case to India.

The Sri Lankan government also focused on the license that are given to trawlers who are engaging in fishing in Sri Lankan waters. The law should be strict and strict remedies should be established with regard to healthy fishing practices.

A research station in the island of Kachchativu manned by National Aquatic Resources Research and Development Agency (NARA) where it investigate of alleged offences and consider merits and demerits of both countries. If all efforts fail in finding an amicable solution, the government of Sri Lanka should be ready to refer the dispute settlement with the help of appropriate international authorities on the strength of UN Resolution 70/1, Goal 14: 'to conserve and sustainably use oceans and marine resources for sustainable development'.

## IV CONCLUSION

This is the high time to take necessary actions to ban bottom trawling in Sri Lankan waters by both state parties India and Sri Lanka which creates massive destruction to ecosystem and threat to human life. Moreover to promote healthy fishing practices within this region in order to conserve the environment. At the same time both India and Sri Lanka should ready to stick with the Sustainable Development goal no 14 to conserve and sustainably use the marine resources and ocean.

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# SECURITIZATION OF NATIONAL BORDERS: A CASE STUDY OF SRI LANKAN BORDER CONTROL MEASURES

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**Abstract** - National border is vital for survival of a state and protecting it is important for National security. Paying lip service to security of National borders will maintain the threat level to the National borders which in turn will impact on National security, economic security and societal security. The objective of this research is to expand the concept of securitisation and identify methods to increase the levels of securitisation taking National border as a referent object.

For this Sri Lanka's border security was studied where increase in drug trafficking was seen post 2009. One aspect of increase in the level of securitisation is strengthening of capabilities of organisations tasked with National border security which will result in effective border protection. Securitisation level can be strengthened by improving the organisational structure, operational capabilities, use of high technology and economy of effort by all actors in addition to enacting required legal provisions. In conclusion; governments should apply appropriate securitisation levels against existential threats to national borders to make border security effective.

**Keywords** - National Security, National Border, Securitisation, Existential Threat

## I.INTRODUCTION

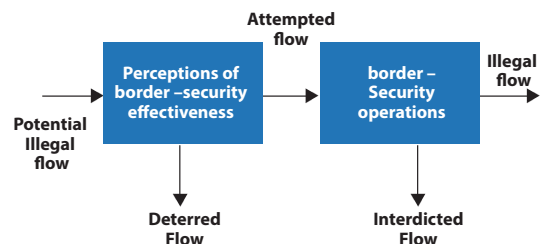
Westphalia sovereignty is a concept that all nation states have sovereignty over their territory and the international community has agreed to respect the principle of territorial integrity. Border depicts the sovereign territory. Border Control is defined as measures taken by a state to regulate and monitor its Borders. National border is vital for survival of a state and protecting it is important for National security. When a nation has threats, it is insecure. It has to develop a strategy to survive or overcome threats

in order to achieve security. Therefore, security is freedom from threats. National security is state survival. In order to survive, the border should be controlled and protected through properly structured and empowered defence organisations.

### A. Concept of Border Security

Effective Border security operations depends on capable security organisations. US Homeland Security and Defence Centre recommends the following fundamental functions for border security (Henry Willis, 2010):

- Interdiction – disrupting illegal movements across borders
- Deterrence – convincing would be smugglers, criminals or terrorist not to attempt to cross borders illegally.
- Exploiting networked intelligence – contributing to and using shared intelligence and information across organisational boundaries.



**Figure 1: Conceptual Model of Border Security**  
(Source: Technical Report to Homeland Security and Defence Centre, 2010)

This is a basic concept using core functions of border security. The percentile of the deterred flow may depend

on the perception of the border security. If the perception is high, the percentile of deterred flow may be high. The balance flow may attempt to cross the border taking a risk which will increase the price. At the border, a percentile of the attempt flow will get interdicted. The balance will get into the country as illegal flow.

### **B. Transnational Organised Crimes (TOC)**

Security threat is more prominent regionally because threats travel more easily in short distances over long distance. This implies that the security threat is severe in intra-region than inter-region. Therefore, Security is interdependent within a region but very rare among regions. Therefore, with the globalisation and increase in TOC, the most practical type of security for South Asia is the Regional security concept.

Louise Shelly says:

“ that increased movement of people and goods, one aspect of globalisation has coincided with increasing economic and demographic disparity between developed and developing countries. This has resulted in an increase in transnational crime groups who facilitate illegal immigration for those who cannot enter developed countries legally. Therefore, the growth of transnational organised crimes has placed enhance emphasis on Border Security (Shelley, 2006).

Transnational Organised Crimes (TOC) will impact on National security to reduce the degree of survivability.

### **C. Securitisation**

“Securitisation means an issue is presented as an existential threat requiring emergency measures and justifying actions outside the normal bounds of political procedure” (Barry Buzan, 1998).

Existential threat to National borders impact on National security and sovereignty. National security and sovereignty are the most vital for survival of a state. Hence, states should securitised the National borders to secure it from any type of threat including of TOC. Countries where TOC rate is very high, have become fragile states.

### **D. Statement of the problem**

All the countries in the world have securitised their National borders using various methods. However, still all the countries face TOC at various levels. It is a puzzle how TOC occur in states where the National border is securitised.

### **E. Objective**

To find whether there is any factor affecting securitisation of National borders.

## **II. METHODOLOGY**

Sri Lankan border security was taken as a sample to identify the security effort or lack of it to understand the puzzle. In that steps taken to prevent smuggling of narcotics across Sri Lankan border was studied to understand border security of Sri Lanka. Border security agencies were evaluated to identify shortcoming in the exiting processes and quantitative method was used to collect data to analysed border violations which has resulted due to weak processes. The information collected were examined against the core functions of border security.

## **III. RESULTS AND DISCUSSION**

### **F. Interdiction**

In terms of interdiction effectiveness of border security could be measured by the volume of drugs seized at the border and inside the country. Availability of heroin at street level indicates failed efforts of interdiction. It is observed that the quantity of narcotics seized in Sri Lanka since 2013 has increased in many folds. The percentile of drugs seized at the border has increase from 11% in 2010 to 60% in 2014 out of the total quantity detected. If the quantity of narcotics which was not detected inside the country has increased, then the 60th percentile will decrease. However, it could be safely assumed that 40% - 60% have manage to cross the border undetected. DG Customs has acknowledged that drugs concealed inside fruits or machine made sealed ampules cannot be detected. It is stated that 3.5Tons of heroin is smuggled in to Sri Lanka and 2.6Tons are smuggled back to Europe and Australia. International Narcotics Control Board has stated in their report for 2014, that Sri Lanka is a hub for narcotics to transit drugs coming from Pakistan, Afghanistan and India to Europe. Sri Lanka has a coast line of 1,340km long. Large quantities of narcotics enter in to Sri Lanka through the stretches between ports of entry. Narcotics smuggle from India enter the border between Mannar – Kalmunai and Velvettithurai - Mulaitivu whilst narcotics from Afghanistan smuggle by Pakistanis, Iranians and Maldivians cross Sri Lankan border at South. Coast Guard does not have adequate resources to fulfil constitutional obligations. 75.4% of container handling in Colombo Port is for transshipping and in fact Sri Lanka

has transhipped 3.7 Million TEUs in 2015. It could be assumed that transshipping is used to re-smuggle 2.6 Tons out of Sri Lanka. Hi-tech scanners are required to monitor approximately 10,000 containers per day.

The 'on arrival visa' process and lack of bio metrics at the immigration at the points of entry hinder border security effort. Further, access to forged birth certificates would allow obtaining of erroneous passport. All these factors contribute for border violations.

**G. Deterrence**

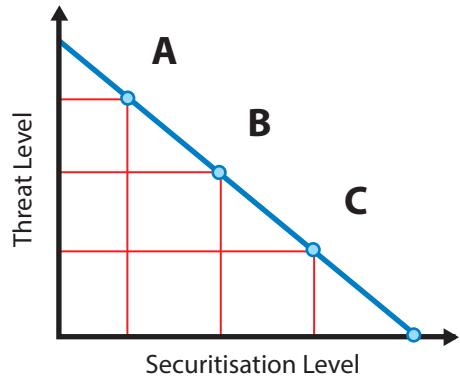
In Sri Lanka deterrence could be measured through the number of convicted prisoners for drug related offences. The percentile for narcotics related convicted prisoners for each year from the total number of convicted prisoners are maintained within the range of 30%-45%. However, 45%-55% from the number of narcotic related court cases are acquitted each year due to various reasons.

**H. Exploiting Networked Intelligence**

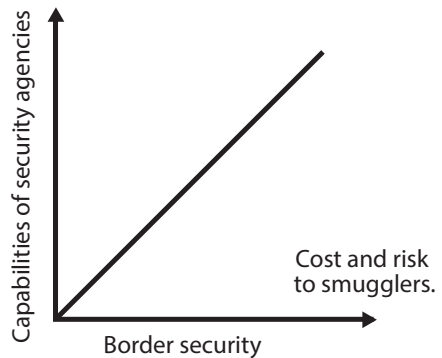
There are 4 departments under 3 Ministries responsible for border security at the ports of entry. This structure undermines economy of effort and affects intelligence sharing. This situation hampers counter narcotics operations.

**I. Concept of Securitization Levels**

Sri Lanka Government has securitized the border to secure National Security and Sovereignty. But the border is being violated on the daily basis endangering Economic security and health security of the country and most importantly regional and world security by acting as a hub for narcotics transshipment. The reason for continuous border violations could be the extent of securitisation of the border. Securitisation could be strengthened or the 'Level of securitisation' could be increased by establishing effective security agencies, posting adequate resources, enacting strong legal provisions to arrest, detain and punish criminals who violate the border.



**Figure 2: Relationship between Securitization Level and Threat Level**



**Figure 3: Relationship between capabilities of security agencies and border security:**

**III. CONCLUSION**

Any government will securitize the border to protect territorial integrity and thereby sovereignty. The securitisation is done by establishing security agencies and enacting laws to protect the border through core functions of border security; interdiction and deterrence. Respective governments should make these security agencies capable by allocating necessary resources in terms of budgets, skill man power, assets, hi-tech equipment and with required legal powers. These resources and legal powers will increase the capabilities of the security agencies. The extent the government's increase the capabilities could be termed as 'Level of securitisation'. The threat level at the border will depend on the Level of securitisation of the border which will depend on the capabilities of border security agencies and laws related to border security.

**Table 1:  
Relationship between Securitization  
Level and Threat Level**

<b>SECURITIZATION LEVEL</b>	<b>THREAT LEVEL</b>
A One security agency, Insufficient budgets and resources including manpower, Weak legal provision to arrest.	(High Increases with time
B A few security agencies empowered for security, Just manageable budget and man power, normal legal course for arrest	Medium (Threat is maintain by thegovernment)
C Many security agencies under one authority to cover all aspects of the threat, sufficient budgets, assets and HR are allocated and strong legal provisions are enact to deter offenders.	Low (Eliminate the threat with time)

Capabilities of security agencies will depend on new processes, additional resources, assets and new technology

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# POLITICAL POLARIZATION OF THE INDO-LANKA FISHERY DISPUTE AND ITS COMPREHENSIVE SECURITY IMPLICATIONS

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**Abstract** - Sri Lanka and India are two neighbouring states in the Indian Ocean, separated by the narrow strip of water that consists of the Palk Bay, and the Gulf of Mannar. The fishery dispute between the two states is a persistent problem of which the Indian fishermen crossing into Sri Lankan waters for illegal fishing and using illegal fishing methods such as bottom trawling is persistent to date. Even though demarcation of territorial waters is not as easy as land demarcation, the territorial waters between India and Sri Lanka was demarcated and designated in 1974 and 1976 by a bilateral agreement between India and Sri Lanka to establish the International Maritime Boundary Line (IMBL). Accordingly, transgressing the IMBL into Sri Lankan waters and to fish illegally and use illegal methods of fishing are recognized as violation of these agreements between the two states which is governed by the United Nations Convention on the Law of Sea (UNCLOS). However, India – Sri Lanka friendly relations have been governed by geo-strategic relations, international politics, diplomatic relations, and ethnicities. Yet, Political polarization and colouring is a contributory factor to this fishery conflict. For political gains and vested political interests of politicians who are even stake holders to the fishery dispute between India and Sri Lanka at various levels have influenced this dispute, and is evident that it bears negative influence on sourcing a lasting solution to this problem. As a result of this persistent fishery problem and the political influence have created serious comprehensive security implications on traditional and non-traditional to both states. The objective of this study is to analyse and critically evaluate this Indo- Lanka fishery dispute in the back drop of its political polarization and colouring and its implications to security. This study would be guided by the exploratory research methodology and data collection through qualitative interviews of stake holders to the problem and available literature, and Grounded theory to be used for data analysis.

**Keywords** - Fishery Dispute, Political Polarization, Security

## I. INTRODUCTION

The Indian Ocean is the third largest water body and it is of strategic importance to all states within amounting to almost 30 nations and historically played an active part in civilization in navigation and fishing (Srilatha, 2013). The ocean amounts to 71% of earth's surface and as much as the land the Ocean too is rich in resources, to the extent the ocean is called "our last frontier" (Kohli, 1993, P: 28) as the ocean is a source of hope for human kind in aspects of survival.

"The maritime interests of a nation are determined by its strategic aims and national policy" (Kohli, 1993, p:62). The maritime environment of both countries India and Sri Lanka contribute to national interest and security of both the states.

India and Sri Lanka are two neighbouring states, geo strategically located in the Indian Ocean and separated by the narrow strip of water that consist of the Palk Bay and the Gulf of Mannar (Jayasinghe, 2003). These two states have been sharing many commonalities over a significant period of time. Some of the commonalities are ethnicity, language, religion, cultural similarities, and even inter-marriages that brings about close ties among these people (Swaminathan and Suryanarayan, 2011), another significant commonality is fishing, on both sides among the coastal people that depend on the Indian Ocean for a livelihood in India as well as Sri Lanka. Yet, it has been observed that for some time, India and Sri Lanka has been disputing over this narrow strip of water over fishing issues and above all, over illegal fishing methods used by the Indian Fishermen in the Sri Lankan waters, and to date

this fishing dispute remains unresolved causing security concerns of traditional as well as none traditional security to both states.

Even though historically there has been evidence that fishermen from Tamil Nadu and the North of Sri Lanka has been fishing in this contested area of sea and called it historic fishing grounds, yet, a clear demarcation of boundary was established in 1974 and 1976 through bilateral agreements between the two states, which has been governed by the United Nations Convention on the Law of Sea (UNCLOSIII). This agreement demarcated and designated the waters between the two states and the International Maritime Boundary Line (IMBL) was established with Kachchativu Island falling within the Sri Lankan waters. Even though these two agreements gave provisions for innocent passage in this controversial waters and access of Kachchativu for Indian fishermen to dry their nets and attend the St. Anthony's church festival it never gave provision for illegal fishing activities within the IMBL in Sri Lankan waters to Indian Fishermen (Bogolagama, 2017).

Poaching takes place within the Sri Lankan waters, in and around Palk Bay, Palk Strait and the Gulf of Mannar, Indian fishermen transgress the established International Maritime Boundary Line (IMBL) into the Sri Lankan waters for a lucrative harvest of fish and worst still, not only do they transgress the IMBL but they also engage in an illegal method of fishing known as bottom trawling (De Silva, 2008). Bottom trawling is considered to be a detrimental method of fishing that Suriyanarayan's study states as "hoovers of the shelf bottom" and "Bulldozers mowing down fish and other benthic species". This has led to a conflicting situation between the fishery communities of Northern part of Sri Lanka and of South India, Tamil Nadu. According to Ahilan Kadiragamar, fishing is the livelihood of the northern community and is of economic importance as the 'province contributed to over a third of the total catch of the country's total catch of fish' (Suriyanarayan, 2016).

Conflicts over the fishing dispute between the transgressors and the Sri Lanka Navy (SLN) as well as the Northern fishery community are many. Conflicts have arisen between Northern fishermen using traditional methods of fishing with the Indian trawlers using mechanized methods. Suriyanarayan, notes that, 'there are 3,407 mechanized fishing boat trawl netters, most of them operating from Rameshwaram' (Suriyanarayan, 2016), which is a clear indication that many trawlers cross the

IMBL into Sri Lankan water for trawling and poaching activities. These numbers have been further confirmed by satellite captures by the SLN and even considering the attests by SLN.

Even though, the Indian side of the interpretation depicts this crossing over of Tamil Nadu fishermen as traditional fishermen accidentally crossing the IMBL well, it has proven not to be so. Many apprehensions of Indian fisherman by the Sri Lankan Navy has been recorded, these fishermen have been tried in Sri Lankan courts for trespassing and their boats confiscated. Yet to date, the transgressing of Indian fishermen takes place and it remains a recurrent problem. There are many aspects to this problem and one of the aspects remain to be the politicization and political polarization concerning the two states.

Political polarization and colouring that contribute along with other political factors on both sides of the bay has been observed as an important contributing factor for this fishery dispute between the two states to remain unsettled to date (Bavinck, 2017). There is much evidence that this fishery dispute has been played for the political and economic convenience of the Tamil Nadu politicians while on the other side of the IMBL due to various reasons the problem has been soft peddled political for convenience, diplomacy and to sustain good relations with India.

While the Indian side of politics, specifically Tamil Nadu politics seems to be playing the fishery dispute to their own political, economic gains and conveniences, the Sri Lankan side of politic is more concerned of maintaining good will and bilateral relations among the two states and has been not hard pressed for a solution.

This unresolved fishery dispute bears much impact on comprehensive security of both states. More so on Sri Lanka being an island state and the coastal people depending on the sea for a livelihood. And on traditional aspects of security threatening even the sovereignty of Sri Lanka when the already established agreements are violated and the Indian fishermen cross over to the Sri Lankan waters.

## II. FISHERY DISPUTE AND RISE OF SECURITY THREATS FOR SRI LANKA

It has also been observed that there are traditional and human security implication due to Indo-Lanka fishery issues which impact comprehensive security at large. Traditional security is threatened when the sovereignty of

Sri Lanka is challenged when fishermen cross the already demarcated IMBL and disrespecting the agreements of 1974 and 1976, get into confrontations with the Sri Lanka Navy. According to Admiral Colombage's study 'a large number of Indian fishing trawlers coming very close to Sri Lankan coast can have serious traditional security implications should the LTTE try to reorganize their violent movement as well as trans national crime. On the side of human security fishermen's livelihood issues, marine eco destruction and negative impact on the environment, food insecurities, are evident due to Indian fishermen crossing over to Sri Lankan waters to engage in illegal fishing activities.

Security is a contested concept says Buzan. In spite of its dominance in state concerns, security is yet to be given one single definition (Buzan, 1991), yet, security is of profound importance to humans and states alike, and in today's context traditional and human security components are linked to each other and there is a renewed awareness about the human security needs and measures to protect these needs in order to ensure that on an overall comprehensive security is maintained.

While Traditional Security gained momentum in the aftermath of the Cold War, human security emerged recently as 1994, taking on a new dimension known as 'human security', yet today security has gone beyond both these aspects of traditional and human security and comprehensive security has been formulated to encompass both these aspects of security under one concept.

Traditional security gained momentum during the Cold War and views the state as the single actor to ensure her own survival in the International system. Walter Lippmann who coined the term 'Cold - War', also defined security which fell in line with the Cold-War which had a traditional focus of security (Hough, 2008). "A nation has security when it does not have to sacrifice its legitimate interests to avoid war and is able, if challenged, to maintain them by war" – Walter Lippmann (Wolfers, 1952)

It was a common notion at the end of the Cold War that traditional security alone cannot provide security for all, states as well as humans, thus, rethinking of the concept of security emerged in the 1990s. A salient aspect of rethinking of security was based on the physical, human dignity and development of the human being (Subur, 2003) to protect the core and values of human beings. Thus, the relatively new concept human security was put forward in 1994.

Comprehensive Security emerged in the 21st Century and the late Swedish Prime Minister Olaf Palme is most often credited for having pioneered the concept of Comprehensive Security (Schmid, 2007). Comprehensive security advocates a shared security culture to encompass a broader understanding of security, and it extends beyond state centric military aspects of traditional security to amalgamate human security that concern people centric security (Schmid, 2007).

Comprehensive Security also considers security within a state as well as outside a state, and as stated by Hsiung, "various components of comprehensive security are intertwined" (Hsiung, 2004) and a "Convergence of all aspects of security culture" (Schmid, 2007) where security is understood and practiced in a more comprehensive manner.

### III. THE INDO – LANKA FISHERY DISPUTE

The fishery conflict between India and Sri Lanka has been an on-going one and poaching takes place within the Sri Lankan waters, in and around Palk Bay, Palk Strait and the Gulf of Mannar. The Kachchativu Island, which is on the Sri Lankan side of the International Maritime Boundary Line (IMBL). The IMBL, which was agreed upon based on the agreements of 1974 and 1976, governed by the UNCLOS demarcates and designates the waters between India and Sri Lanka, in the Palk Bay, Palk Straits and the Gulf of Mannar.

However, considering the traditional and historical fishing grounds enjoyed by the Indian fishermen around the island of Kachchativu, certain rights were given to the Indian fishermen to dry their fishing nets and perform religious rights on this island but never fishing rights.

Despite the clear demarcation of the IMBL, violations take place almost daily, and illegal fishing takes place within the Sri Lankan waters posing a threat to the security of the country. Indian fishermen and their trawlers enter the Sri Lankan territorial waters which is the main cause towards the Indo – Lanka fishery conflict (de Silva, 2008).

As per the Marine Conservation Institute, 'bottom trawling is an industrial fishing method where a large net with heavy weights is dragged across the seabed, scooping up everything in its path-from the targeted fish to the incidentally caught centuries –old corals' (Colombage,

2016). Given the good relations between New Delhi and Colombo most often apprehended fishermen are released on friendly negotiations.

### **A. Politicization and polarization of the Fishery dispute**

Politicization and political polarization that contribute along with to other political factors on both sides of the bay has been observed as an important contributing factor for this fishery dispute between the two states that remain unsettled to date (Bavinck, 2017). There is much evidence that this fishery dispute has been played for the political and economic convenience of the Tamil Nadu politicians while on the other side of the IMBL due to various reasons the problem has been soft peddled for political good will with India and convenience. Suriyanarayan, observes that the Sri Lankan fishermen repeatedly have been appealing to the SLN and the government to intervene and prevent the Indian fishermen fishing in Sri Lankan waters. Yet, it can be observed that even though apprehensions do taken place most often the problem has been ignored, accordingly the fishermen on the Sri Lankan side lament that 'Colombo is more willing to promote bilateral relations than to ensure the stability of their livelihoods' (Suriyanarayan, 2016). Given such evidence of taking a stance of lenience in the face of this recurrent problem of the fishery conflict that threatens the livelihood of the Sri Lankan fishermen, it leads to the question whether actually as alleged the fishery conflict has been politically 'soft peddled' on the Sri Lankan side of the IMBL. On the other hand, relations between New Delhi and Sri Lanka improved with the regime change in 2015, and a promising note struck to the fishery problem when both governments committed themselves to "find a permanent solution to the issue" (Suriyanarayan, 2016).

Taking into consideration the political developments on the Sri Lankan side of the waters, as recent as 6th July 2017, the government of Sri Lanka took a bold but eminent and timely stand with regard to the fishery issues and the laments of the Sri Lankan fishermen. Looks like the cry and plea of the poor fishermen fighting for a livelihood after all did not fall on deaf political ears. On the 16th July 2017, the Sri Lankan Government intervened to implement a ban on bottom trawling by amendment to 'section 28 of the fisheries and aquatic resources Act of 1996 (Illanperuma, 2017). According to Steve Creech, the governments apt move 'reiterated the Government's commitment to sustainable exploitation of the country's vital fishery resources' at the same time protecting the

traditional fishermen of Sri Lanka and their livelihood (Creech, 2017). Yet the political views from the Tamil Nadu side with regard to the recent political move on ban on bottom trawling and the consequences obviously has not been accepting and welcoming. Tamil Nadu Chief Minister has condemned this change of political stance and amendments to our Fishery Act, and called it 'retrograde step' and even written to Prime Minister Modi to intervene in this matter. While the Tamil Nadu bottom trawling fishermen has called this ban 'Draconian' (Illanperuma, 2017). Political influence does call the shots may it be positive or negative in this dispute. When Sri Lanka has finally acknowledged the problem and has taken bold yet necessary steps to combat the issue in a civil manner, yet, the Tamil Nadu side of political influence is tugging the fishery issue in the opposite direction, solely for their benefits, which again is a threat to human security for Sri Lankan fishermen.

This goes to show that there is much political intervention and interest on both sides yet, this very same politicization has to a greater extent hindered a solution to the problem. While the Indian side of politics, specifically Tamil Nadu politics seems to be playing the fishery dispute to their own political, economic gains and conveniences, the Sri Lankan side of politics is more concerned of maintaining good will and bilateral relations among the two states and is not hard pressed for a solution until the recent ban which is a major step to arrest this conflicting situation.

### **B. Research Problem and Objectives**

Fishermen from Tamil Nadu transgressing the IMBL into Sri Lankan waters for poaching and bottom trawling is a recurrent problem which has led to much concern and even conflict between the Indian fishermen and the Sri Lankan fishermen. This has caused much traditional as well as human security concerns. Sri Lankan fishermen are faced with human insecurities of livelihood, food and environmental insecurity to name a few as the fishery resources are being depleted and bottom trawling causes long lasting damage to the marine eco system as well as to the cost line of the country. The destructive fishing methods used by Indian fishermen and over exploitation of marine resources could have far reaching human security implications especially for Sri Lanka fishermen.

The objective of this study is to identify and analyse various aspects of the Indo- Sri Lanka fishery conflict and to what extent politics and political polarization has influenced this fishery dispute between India and Sri Lanka. To highlight

the importance of the fact that, if a lasting solution is to be sought for this fishery dispute, then political influence and manipulation from either states or politicians vested interest to be minimal.

### C. Methodology and Research Design

It is going to be of exploratory in nature. The problem is not clearly defined and hence the exploratory research method is considered as the most suitable one for this research. The researcher wants to locate herself in the social world to understand the perceptions and the views of people who are stakeholders to the problem. Therefore, hopes to select the qualitative research design over a quantitative one.

Qualitative Research can be considered as the pathway of pragmatic curiosity by exploring the research interests. It can also satisfy the investigative curiosity and provide effective procedural choices. Qualitative research methods focus on discovering the experience, perceptions and thoughts of participants. Most likely qualitative research methods can be named as Exploratory, Naturalistic, Subjective, Inductive, Ideographic and Descriptive/ Interpretive. Exploratory research can be described as a researcher's tool to understand an issue more thoroughly. Exploratory research will provide rich quality information that will help identify the main issues that should be addressed. Since this Indo-Lanka fishery issue is a very complex and unspecified one which involves traditional as well as human security implications to people the researcher will use exploratory research method for this study.

### D. Theoretical Background

Securitization theory put forward by the Copenhagen School and theorized by Buzan, Waver and de Wilde, takes the approach of social discourse to security issues. According to Huysmans (1997) "possibly the most through and continuous exploration of the significance and implications of widening security agenda for security studies". Securitization, stresses the importance of "dialogue & speech act" in looking beyond traditional security in "deepening and widening of security". Therefore, securitization can be used in seeking solutions to problems covering areas military, political, environmental, economic and also societal (Buzan et al, 1998).

Securitization can be extended to develop solutions for the fishery problem as this case study relates to many of the areas covered in Securitization, namely, military, political,

environmental, economic and also societal (Buzan et al, 1998). The Indo-Lanka fishery problem relates to almost all of these aspects. Securitization also attempts to bridge traditional and human security as it goes beyond traditional security to aspects of human security to comprehensive security and also, focuses on negotiated settlement to problems.

The researcher therefore hopes to adopt Securitization Theory in the study of the case of Indo – Lanka fishery issues with a view to analyze the political influence and manipulation to this problem and to find out how to minimize political influence and manipulation of the problem in concern so that it remains hindrance free towards a solution.

### E. Discussion

The Indo- Sri Lanka fishery conflict has been an unresolved issue which has even affected the bi-lateral relations between the two countries. Although there had been many political, diplomatic and societal initiatives, there had not been a solution so far and the situation is aggravating. If this conflict is not resolved, it could lead to drastic consequences for traditional maritime security concerns for both the countries and, human security issues mainly for Sri Lanka's northern fishermen. On an overall, affecting comprehensive security.

Delineating sea is much harder than land, yet, the bilateral agreements of 1974 and 1976 governed by UNCLOS III, clearly demarcated and designated the waters between India and Sri Lanka. This agreement provided the guidelines and limitations for both states using the sea between the two states. Even though this agreement did provide provision for right of innocent passage for navigational purposes, yet, it did not provide any provision what so ever for fishermen of either states to cross the IMBL into either states water for fishing activities. Yet, the Indian fishermen daily cross the IMBL into the Sri Lankan waters in search of a 'better catch' (Fonseka, 2017). The Indian trawlers not only cross the IMBL and enter Sri Lankan waters, they are engaged in destructive bottom trawling or 'benthic trawling' as well. Bottom trawling can have far reaching negative consequences to the rich marine eco system and the marine diversity of the Palk Strait and Gulf of Manna regions. These activities by the Indian fishermen amount to be illegal and quite often Indian fishermen transgressing in the Sri Lankan waters have been apprehended by the Sri Lanka Navy (SLN), trialed on the grounds of trespass, boats confiscated and apprehended Indian fishermen even

imprisoned. Yet given the friendly relations between the two states quite often imprisoned Indian fishermen have been sent back to Tamil Nadu on good will.

Security is of profound importance to states and humans alike. Traditional security in this case is the marine security which is of importance to state and state security concerns and human security that deals with human insecurities due to the problem, both of which attributes to Comprehensive security.

Indo – Lanka fishery conflict shows eminent signs of infringement of comprehensive security which leads to threats at many aspects concerning traditional security which is a matter for the state and human security amounting to human insecurities.

The question arises as to why this conflict remains unresolved and a persistent one. Among many contributory factors the researcher has identified the political aspect to the problem, politicization and political polarization as one of the main reasons as to why this conflict remains unresolved to date.

**F. Way forward and conclusion**

This research therefore, will analyze the effects of politicization and political polarization on the Indo – Lanka fishery dispute. The researcher is also of the view that, if a lasting amicable solution to this problem is to be sought that this problem should be free of undue political intervention with various vested political interests and that a “Multi-Pronged” approach should be adopted to deal with all aspects of hindrance to a solution.

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# TRANSBOUNDARY IMPLICATIONS OF INDIA AND NEPAL AIR POLLUTION POLICY IMPLEMENTATION AND SOUTH ASIAN ASSOCIATION FOR REGIONAL COOPERATION

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**Abstract** – The expansion of environmental politics is a major revolution which was expanded as a form of political activity in international relations. Particularly smog with particulates can be recognised as a transboundary air pollution in the South Asia region. Environmental issue like smog is not appeared frequently on the international agenda even within the banner of some regional cooperation that negotiate some binding environmental agreements. Smog with particulates are generally acknowledged as a threat to the region as well. It means that the South Asian countries are steadily experiencing various grievance of smog with particulates for the last few years. It has also formed health and environment effects to the region. India and Nepal are prominent contributors to smog with particulate air pollution in the region due to industrialization, population growth, and weak implementation of air pollution policies.

Main objective of this paper was to examine the response of SAARC with regard to the problem of smog with particulates in the region. It is true that smog with particulate pollution is a transboundary difficulty to the region where none of the countries can maintain it alone. Further there are inter-governmental agreements to tackle regional air pollution problems such as The Male Declaration on Control and Prevention of Air Pollution which was signed in 1998. SAARC can also play a vital role in regional environment management by establishing regional environment quality standards.

**Keywords** - Transboundary Air Pollution, Environmental Politics, Regional Cooperation, Policy

## I. INTRODUCTION

“Air pollution is contamination of the indoor or outdoor environment by any chemical, physical or biological agent that modifies the natural characteristics of the atmosphere. Household combustion devices, motor vehicles, industrial facilities and forest fires are common sources of air pollution.

Air pollution can be categorized in to two types such as smog and particulate air pollution and carbon emissions which provide effects for climate change as well as global warming. These air pollutants which spreads across more than one country and it is called trans-boundary air pollution. Yet this air pollution contributing to problems that range from human health issues to environment degradation.

Transboundary air pollution require international actions and collaboration to control their formation and effects. It cause a number of different problems: Eg: formation of particles, ground level ozone which are hazardous to health, the formation of acid rain which can damage buildings and sensitive ecosystems and some that are toxic to human health and the environment. Transboundary air pollution has associated with adverse human impacts and it is a major source of morbidity and mortality .The young and the old with vulnerable immune systems are most at risk from this pollution. Smog with particles can irritate the eyes and throat, irritate the skin and damage lungs especially of people who work or exercise outside, children and senior citizens. Long term exposure can lead to more



serious health problems such as impaired lung function and higher rates of pulmonary disease.

India suffers considerably from air pollution, having four of the top ten cities with the highest concentrations of PM<sub>2.5</sub> in the world according to the World Health Organization. And despite Indian authorities adopting ambitious pollution control measures, the anticipated economic growth in India might further deteriorate Delhi's air quality.

India's toxic air reaches Nepal when the air blows in certain directions, covering skies with thick smoke haze mostly in summer period.

This trans-boundary air pollution effect on public health. Especially trans-boundary air pollution is common in districts of Nepal sharing a boarder with India. Delhi and the cities of Utter Pradesh which frequently rank among the worst polluted in the world are few hundred miles away from Kathmandu in air distance. Also the resulting smoke of straw left over from the harvest in North India is toxic which blows the atmosphere of Nepal. There is no direct control over cross boarder air pollution.

Trans-boundary air pollution is changing the atmospheric process in the South Asia, melting the Himalaya glaciers and affecting the ecosystems, agriculture and food security in the South Asian countries. Air Pollution affects aviation, railways, agriculture, monsoon and the countries' economies as well. The black carbon rises into the atmosphere and is driven by winds on to the snow or ice in the Himalayas, darkening the surface and in the process reducing reflectivity and causing the surface to absorb more heat. Also the historic site of Buddha's birthplace in Nepal faces a serious threat from air pollution.

South Asian countries such as India and Nepal face rapidly growing health hazards associated with indoor and outdoor air pollution caused by extensive use of biomass for energy, poor sanitation and waste management. India and Nepal need to adopt effective pollution control measures in urban and rural areas and negotiate and implement trans-boundary air pollution abatement measures at regional level such as the Male Declaration on Trans-boundary Air Pollution (South Asia Environment, 2009)

South Asian Association for Regional Cooperation (SAARC) could be a possible forum for looking into ways and means in generating possible support for strengthening Male Declaration.

Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka together form the South Asia Association for Regional Cooperation (SAARC), an organization developed to promote regional economic cooperation. Established in 1985, the organization has the core objectives:

- (i) to promote and strengthen collective self-reliance among the countries of South Asia
- (ii) to develop mutual trust, understanding and appreciation of one another's problem;
- (iii) to promote active collaboration and mutual assistance in the economic, social, cultural, technical and scientific fields;
- (iv) to strengthen cooperation with other developing countries;
- (v) to strengthen cooperation among themselves in international forums on matters of common interest
- (vi) to cooperate with international and regional organizations with similar aims and purposes. SAARC support to MD

The level and nature of air pollution in any country has implications for the economy of that country as well as neighbouring countries. The importance of a regional level framework for combating air pollution and its harmful effects can only be assessed after reviewing the socioeconomic situation in South Asia and establishing the impact of air pollution on various socioeconomic parameters.

Once governments and society realize the potential damages caused by air pollution, sufficient support can be garnered at the national and regional levels to combat this environmental hazard. High levels of air pollution have a serious impact on the environmental quality that imposes economic costs associated with reduced quality of life, lost productivity, due to acidification and ozone impacts and health care costs.

The persistent Atmospheric Brown Haze over Bay of Bengal has been traced to emissions from South Asian and South East Asian countries. This haze consists of sulphates, nitrates, organics, black carbon, fly ash and other pollutants. Several key reasons affect the brown cloud of Bengal such as biomass burning, rapid industrialization,

urbanization, industrial air pollution, indoor air pollution (biomass burning), increasing traffic trends, thermal power plants and incineration of solid waste and lack of alternative environment-friendly energy sources are primarily responsible for this haze over South Asia.

The Governing Council of the South Asia Co-operative Environment Programme (SACEP) adopted the 'Malé Declaration on Control and Prevention of Air Pollution and Its likely Trans-boundary Effects for South Asia' in 1998 at its 7th meeting. The Declaration stated the need for the countries of South Asia to carry forward, or initiate, studies and programs on air pollution. The Malé Declaration is the first regional environmental agreement in South Asia to tackle trans-boundary air pollution; the participating countries are Bangladesh, Bhutan, India, Iran, Maldives, Nepal, Pakistan, and Sri Lanka. UNEP is the Secretariat for the Malé Declaration programme. The Male Declaration consists four phases such as Phase 1 – Baseline information and awareness raising, Phase 2 – Capacity building, Phase 3 – Tackling air pollution problems through impact assessment studies and Phase 4 – Strengthening initiatives and developing new ones

## II. METHODOLOGY AND RESULTS

The main research objective is to analysis India and Nepal Trans boundary air pollution policy implications and regional cooperation. Qualitative research methods would be accepted with an exception of quantitative methods. The research design is carried out by analysing existing and previous literature such as conventions, protocols, case studies, discussions and articles etc subjective to qualitative analysis.

Empirical studies carried out by scholars, scientists, focus groups, use of statistics and data published by recognized institutions such as United Nations ,South Asian Association for Regional Cooperation and other government and non-government organizations) to be used. Qualitative data would be collected from individuals such as academics, scientists and policy makers etc Method of data collection would be semi-structured interviews done informally pertaining to Transboundary air pollution policies.

It can be identified that the lack of policies for trans boundary air pollution effects the increase of air pollution level in both counties Air pollutants as a by-product

of unregulated industrial activity, pollution is perhaps the most visible and publicized issue. It may also be the deadliest. The benefits of cleaner fuel types, will be able to reduce the air pollution. According to the information received from various sources the products of agricultural harvests, called stubble, are being burnt in Punjab and Haryana – near Delhi – at an estimated rate of 500 million tons each winter. But anti-burning laws are weakly enforced, and State Pollution Control Boards appear to be negligent on the issue. Also it can be identified that manufactures continue to push back against regulations. The institutional framework linking scientific research and policy formulation is required to achieve regional standards. Trans-boundary air pollution cause an adverse impact on human health, food and water security, climate ,economy and national development goals and several global development goals such as the sustainable development goals(SDGs) within both countries as well as regional countries.

## III. CONCLUSION

Transboundary air pollution is a complex problem. Therefore ,reducing air pollution will require a multitude of commitments and carefully planned actions by a team of scientists, engineers, policy makers and decision makers, politicians, embassies, non-governmental organisations, private sector and committed citizenry at various levels, from government to households and local communities to individuals. It should be integrated into the relevant environment policies, climate change policies, energy policies including alternative energy policies, urban development policies, public health policies, national development policies and goals, as well as with India and Nepal International Commitments such as Paris Agreement on climate change and the Sustainable Development Goals(SDGs). Yet trans-boundary air pollution policies within both countries are not met required standards to overcome the issue, proper regional cooperation is required. The Male Declaration on Control and Prevention of Air Pollution and its likely trans-boundary effects for South Asia is the first regional environment in South Asia to tackle trans-border air pollution through regional cooperation. It would be difficult to control trans-border sources of air pollution, the priority would be to control pollution sources within the countries of South Asia.

The Malé Declaration (MD) was adopted in 1998 and the baseline data continue to be collected, a number

of limitations are noticeable in the Declaration's framework. These gaps and omissions occurred due to poor negotiating process. Fuel consumption, industrial emissions and net vehicle operation have been increased in the SAARC region recently. But the Male Declaration is in a slow progress.

The consistent flow of meetings and activities under Male Declaration should be built upon to share existing knowledge. The intergovernmental forum, successful in its regularity serves is required to elevate the profile of the networks efforts. Stakeholder participation forums are also required and involvement of knowledge sharing among state and non-state stakeholders are required.

Training activities need to be improved but how institutional capacity and capability to retain learning has progressed is questionable, with staff turnover and attrition. It was identified that monitoring stations are located in rural areas to avoid the focused and concentrated impacts of urban pollution. However, while progress has been made in areas such as fuel emissions reductions and technology introduction.

Male Declarations should be implement a policy framework for relevant institutions. The ministries of environment and forestry in the smaller member states are try to form an inter-governmental coalition around the issue of air pollution and Transboundary effects in South Asia.

An institutional omission is the lack of assignment of responsibility of national measures and institutions that are engaged in the task of controlling and abating such pollution. While the state ministries may not be able to point to their adjacent ministries and agencies, non-government stakeholders should be aware of and point to the responsible bodies that should be empowered and engaged to take the pollution abatement forward either through regulatory control or market based instruments and incentives.

The elements of technology should be included into the policy agenda for transboundary pollution control forward. There is a need to focus on technology sharing and solution development, along with regulatory control. Knowledge sharing and best practice mechanisms and institutional arrangements need to be defined and outlined in more detail for administrative bodies at the national levels to follow. More space is required to assessing, studying, strategizing, allocating resources, economic mobilization and network development

Also implementing and responsible agency in the state needs to be assigned and empowered with responsibility

Developing initiatives and working in cooperation to monitor specific emissions and concentrations/levels is in progress but accountable bodies need to be identified. The commitment to national reporting systems, consultation, protocols and institutional structures are all made, but at such a point, it should be identified which agencies are best positioned to carry out and manage the commitments that have been made.

The declaration text and content reflects a good advocacy and awareness campaign protocol. In the inter-governmental forum, the focal points are outlined for each meeting as involving multilateral institutions as well as international non-governmental agencies and national authorities.

The focal points for the national level are merely contacts from the Ministry of Environment and Forests, with natural resources, energy, water and science and technology such as Nepal It is important for the Male Declaration to have more effective links with all the relevant ministries. Inter-governmental partnerships between ministries of economic development, industries and commerce to ensure that all of the necessary growth concerned cells are in partnership with one other. Also the ministries of environment should have initially included the interests of the ministries of health as well as other inter-governmental colleagues. Air pollution mitigation measures are available. They are currently in use in different regions around the world. The fast and large-scale implementation of these proven emission reduction measures would result in immediate and substantial multiple benefits such as save lives, increase crop yields, protect climate, and improve socioeconomic conditions. However, many key challenges still remain with such widespread interventions. We need to identify solutions grounded in sound science and carefully examined local specifics so that they are the best local options to ensure cleaner air. Therefore, scaling up clean air solutions would require substantial strategic investments, such as an innovative combination of existing policies, new policies, off-the-shelf available existing technologies, new technologies, resources (human, financial, institutional etc.), non-technological measures, including individual and collective behaviour change to choosing less polluting options, and most of all coordination and cooperation among government agencies, development partners, private entrepreneurs, non-governmental organizations, and the general public.

SAARC has organized different summits since 1987 focusing on climate change and natural disasters. The SAARC Environment Action Plan was adopted by the 3rd Meeting of the SAARC Environment Ministers (Malé, 15-16 October 1997). This action plan identified some of the key concerns of Member States and set out the parameters and modalities for regional cooperation. The action plan was based over the fundamental principles of causes and consequences of natural disasters, protection and preservation of environment and greenhouse effect and its impact on the region. A number of measures outlined in the SAARC Environment Action Plan have been reportedly implemented.

While SAARC has been in function for about 35 years now, the impact of its framework, especially with regard to air pollution reduction and control is yet to be seen. SAARC needs to be strengthened with a monitoring and evaluation mechanism to observe whether the member countries are making progress in reducing air pollution and minimizing its associated impacts in the South Asia region.

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# SRI LANKA BETWEEN GEOPOLITICAL INTERESTS OF CHINA AND INDIA

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**Abstract** - Sri Lanka has become a point of interest in the Indian Ocean in the 21st century due to her geo-strategically attractive position. Precisely, the pearl of the Indian Ocean is now in dilemma due to the conflicting interests of rising powers of Asia; India and China. India is the mighty neighbour lying nearest to Sri Lanka. Both countries have had crucial relationships from the past days. For India, Sri Lanka can impact on India's strategic and security interests. Thus India is reluctant to the presence of another major power like China in Sri Lanka. On the contrary, Sri Lanka lying on one of the busiest sea routes has attained the economic companionship of China. As a result eventually Sri Lanka had to encompass into the power politics within these countries.

India and China are the largest countries in the world when it comes to population. According to Revision of World Population Prospects (2015), India with approximately 1.24 billion people in 2014, and China 1.39 billion of people in 2014 covers together 36.41% of total population of the world. Even when it comes to global power politics both these countries are considered great powers in global politics.

The paper will provide a discussion on Sri Lanka approach to balance good ties between these two regional superpowers. The objective of this study is to assess the importance of support given by both India and China. Information in this regard will be derived from secondary sources i.e. reference of text books, electronic data bases, journals, etc. Most importantly the paper will propose that this location of Sri Lanka has a great advantage towards the country's successful development if professionally used.

**Keywords** - India, China, Geopolitics, Sri Lanka

## I. INTRODUCTION

Kaplan describes Sri Lanka as a geo- strategic hub in the Indian Ocean as most international business supply will be conducted through this route. This undermines the significance of the Island Nation falls under the mighty Indian Ocean. The independent Sri Lanka retained with the policy of non-alignment ensuring protection and survival from other major state players in the game. Prime Minister Sirimavo in one of her speeches stated, "Underlying the policy of non-alignment is the belief that independent nations, although small and militarily weak, have a positive role to play in the world today. This attitude is completely different from that of washing our

hands of these matters, which was perhaps the idea behind the classical theory of neutralism. That was non-involvement — remaining in splendid isolation. There is, Hon. Senators would agree, a world of difference between this and non-alignment." (Prime Minister Sirimavo Bandaranaike on Sri Lanka's Non-aligned Foreign Policy, speech given to the Senate on 23 January 1964) Therefore the implications made by this speech were as, though Sri Lanka was nonaligned, she did not play the role of a neutral state. Despite that, Sri Lanka had close ties with India from the ancient times and both countries shares common values. At present Sri Lanka is known to be the India's second largest trading partner in SAARC and India in turn is Sri Lanka's largest trade partner globally.

On the other hand, Sri Lanka's ties with China has made drastic developments on the country's economy. With China bilaterally developing strategic ports dotted across the region, the project has concerns on Sri Lanka's

Hambantota harbor linked to the string of pearls in the Indian Ocean. Given that the string of pearls includes other port as Chittagong, Marao, etc. Hambantota harbor will be the most influential in economic development of the region for its proximate location in the strategic Indian Ocean East-West shipping arterial. Taking Hambantota as a key port in the string of pearls, China intends to secure its place in the Indian Ocean to expand their interests.

One of the important questions raised here is that China having invested in the Western countries throughout the past year is now turning towards the Asian countries to invest. China's ties with the island nation is mainly based on soft power diplomacy. It is assumed that Currently, Chinese companies are involved in a number of infrastructure, communication and port development projects which enhance the strategic importance of Sri Lanka funded by Chinese bank loans. These include the Hambantota port project Phase-I completed at a cost of \$360 million and 85% financed by the Chinese. (Colombo Telegraph, 2013).

The Mattala Rajapaksa International Airport near Hambantota built at an estimated cost of \$ 210 million completed in March 2013. The Colombo South Container terminal built by a joint venture company in which China Merchant Holdings Company holds 85% share makes Colombo Port complex one of the biggest in the world. Moreover greater attention has been paid over the Chinese deals to build telecommunication and information technology networks in Sri Lanka as the Nelum Kuluna (Lotus Tower) project.

It is stated that Lotus Tower will facilitate the transmission of signals of 50 TV Channels and over 35 FM Radio Stations with (TRC, 2014). The said constructions led by the investments of China would to be great leap forward for Sri Lanka's development.

However India despise Sri Lanka's relationship with China. India has led to predictions that the Lotus tower would increase China's options to espionage on Indian military and Indian Ocean communication and to carry out electronic warfare. Nevertheless, later it was published in Hindustani Times, Karunasena Kodituwakku, the Sri Lankan ambassador to China, had told media persons that Colombo will not allow China to set up a military facility at any port in the country. Further Chinese investors have also been informed that no civilian facility will be allowed to be used militarily so as to prevent befall of any complicated situation.

### **A. China's geopolitical ambitions**

In geopolitical terms Sri Lanka falls within the politics of China. According to the maritime strategist Alfred Mahan, 'Whoever controls the Indian Ocean will dominate Asia; the destiny of the world will be decided on its waters.' (Tamil Nation, 2007) China with the motive of taking control over the Indian Ocean is engaging with development projects in Sri Lanka whose strategic position in the Indian Ocean.

The proposed 21st century silk route is a diplomatic initiative taken to keep closer ties with South Asian countries, and Sri Lanka will act as the hub that connects Asia and Africa. Thus China's goal to create a Sino-centric Asia is gradually achieved through strategic cooperative partnership with other Asian states.

China has become persuasive during the past years. They have now economically empowered passing US. With the decline of global economic output by United States, China's contribution has risen every year. China had not only increased her economic engagement but also the military engagement. Particularly where China's navy expanding its defensive power throughout artificial islands in the South China Sea unveils her interest in dominating the Oceans.

In addition, China's concerns over cyber warfare has escalated with the years and at present China plays an active role in cyber espionage which has become a threat to the regional politics. Targeting cyber-attacks on Hong Kong government agencies before the city's first legislative election is one incident which China was alleged of involving.

### **B. China's geopolitical interest towards Sri Lanka**

China is the world's largest economy by purchasing power parity terms and at the same time the largest trader in the world. China now will be the next great super power challenging the dominance of US. Moreover they are in their extreme level of economy. To develop their economy they must enhance the investment and the trade actions with the third world. Thus it will be an enormous opportunity for Sri Lanka with Chinese ongoing projects.

China has proposed two main projects; 21st century maritime silk route and the land route. Sri Lanka is going to be a big part of this maritime silk route. Therefore it is very important to Sri Lanka as it gives ample of opportunities.



**Figure 1. A map of Indian Ocean with sea routes**

China's Defence Minister General Liang Guanglie visit's Sri Lanka in August 2012 was kept at a low profile. However, the Chinese press release on the visit was a little more explicit. It quoted General Liang as saying that political trust between the two countries had deepened with the rapid expansion of exchanges and cooperation in various fields. He expressed the hope that the two sides would continue to work hard to maintain the close and friendly relations and strengthen exchanges and cooperation in the field of non-traditional security and improve the ability to respond to crisis together, so as contribute to regional peace, stability and development.

As revival of Tamil separatist insurgency in Sri Lanka appears remote, Sri Lankan armed forces training for such security situations would give them the option of working with Chinese military assistance in such an eventuality. China's active military cooperation in Sri Lanka, literally in India's 'backyard', would complicate India's security situation.

### **C. India's geopolitical ambition**

India's economy is projected to reach the No. 3 spot by 2020 according to some analysts and metrics. It is said that India will surpass Japan, and trailing only China (No. 1) and the U.S. (No. 2). Not only economically but India has also aimed in expanding its land area, especially where India annexed by capturing Sikkim in 1975. Especially India is highly focused on keeping SAARC countries under her reach except for Pakistan.

The diplomatic tension between India and Pakistan even made India to boycott the 19th SAARC summit which was originally planned to host in Islamabad, Pakistan.

India has already started her journey to become a nuclear super power. Though India is not a signatory to the nuclear non-proliferation treaty, they made nuclear weapons, made air craft carriers, missile development space programs. Thus India is carefully projecting herself to a regional power by ending nuclear dependency. India's intent to use nuclear power on both levels of civil and military can be determined as a clear-sighted act to stand alongside with the other globally powerful actors.

### **D. India's geopolitical interest towards Sri Lanka**

During the era of President J R Jayewardene, he intended to have more relations with US and other Western countries. There was a time where an American company bid was approved over an Indian company bid. India's dislike towards J R Jayewardene's foreign policy eventually led India to support internal Tamil militant groups across Sri Lanka. This proves India's interest on keeping Sri Lanka under her control. What Sri Lanka has to understand as a small country is that India's on a clean path to become a global superpower. Aggrieving India would not make any difference to Sri Lanka's development. However keeping close ties with India would help Sri Lanka in her long term success.

India's relationship with Sri Lanka has been troubled during the recent years, mostly due to internal frictions between Tamil interests and the interests of the central government of New Delhi. India's geopolitical interest toward Sri Lanka is not a novel one. It is evident that India dislikes when Sri Lanka joins with external powers. Particularly India despise Sri Lanka keeping close ties with China. If China is to stabilize her power over Sri Lanka it would be an enormous threat to India's security. The Lotus Tower that China built in Colombo gains the fears (that others dismiss) that China will use this tower to intercept Indian intelligence.

President Modi's visit made for the Vesak festival secured that India has her own political motivations towards Sri Lanka. This was the second time President Modi visited Sri Lanka. The first time was in 2015 soon after President Sirisena came to power. President Modi's intentions of having a pro-Indian government in Sri Lanka is one of the main focuses on his foreign policy.

India's another concern is Trincomalee oil facility. However when the present government tried to make a deal with India to jointly operate a strategic oil facility, the state petroleum entity's trade unions staged the strike against the proposal and halted proceeding with the agreement.

India's interests over the Sri Lankan port are probably more strategic than economic. In order to counterweight China's presence on Hambantota and to dominate the Indian Ocean, India is planning to build Trincomalee Port. At the same time, India is intended to reduce the Chinese influence over the island nation.

### **E. How Sri Lanka can balance the interests of China and India**

Indeed, Sri Lanka's political situation will be influenced as a result of her strategic location in the Indian Ocean. India being the next door neighbour of Sri Lanka is mindful on China's strategic policies in the Indian Ocean. Especially, India is well concerned on the strong Sino-Lanka relationship. Therefore, Sri Lanka has to balance the geopolitical interests regarding China and India. Being a small country Sri Lanka cannot antagonize either China or India at any cost.

In fact, Sri Lanka needs the support of China's investments on massive development projects. The projects that have been conducted so far by China benefitted both nations. Inarguably these projects made Sri Lanka's location more decorated and eminent. It is only natural for India to be worried if China strengthens its ties. Yet Sri Lanka should understand that she needs India's assistance in shaping the peace inside the country and preserving her national interests. Deepening the defence ties with India is a one factor that contributes to ensure national security. Although Sri Lanka keeps defence ties with Pakistan and China, India continues to host and train a large number of security personnel of Sri Lankan Armed Forces than any other country in the world.

Carefully handled negotiation with India will account for a positive influence over the Sri Lankan Tamils as well. The strong anti-Sri Lankan favor of Tamil Nadu politics which has caused serious damage to India's relationship with Sri Lanka can only be overcome through peaceful discussions. The issue of "Palk bay" became a contentious issue throughout the years due to the continuous influence by the Tamil Nadu politics. And these kind of issues should be measured sensitively without going into extreme decision.

India and China are highly militarized countries in the region. If an armed confrontation occurs between these two states it will be a threat to Sri Lanka's national security. Therefore, Sri Lanka has to take a lead role in establishing a movement that demilitarizes the Indian Ocean by

building a regime for peaceful cooperation. Sri Lanka should not welcome any military establishment by China as it will highly affect the diplomatic policies Sri Lanka holds with India.

The policy of non- alignment has always favored Sri Lanka for its existence. And knowing the fact that China and India are the two main donors of foreign direct investments in Sri Lanka, inclination towards only one party will harness the interaction with the other party. Aftermath of the war Sri Lanka is now on the transition for a better peace, therefore mutual understanding between Sri Lanka- China and Sri Lanka- India is principle in gaining momentum for a positive peace and development.

## **II. CONCLUSION**

Due to the strategic location in Indian Ocean, Sri Lanka has attracted the geopolitical interest of the global powers in the 21st century, the rising powers of Asia, India and China has high geopolitical interests in Sri Lanka. With more than 1/3 of the global population and fast economic growth, both India and China are changing the global geopolitical and economic structure in the 21st century. As the part of China's initiative to develop a 21st century maritime silk route, China is investing heavily on the countries in the Indian Ocean. Sri Lanka has become particularly important location for China under this initiative. The highway projects, Port city projects, Nelum Kuluna etc. are massive Chinese investments in the island nation. But the developments in regard to Chinese involvement Sri Lanka is looked at by India with suspicion due to obvious geopolitical reasons. India worry these economic interventions can someday leads to a Chinese military establishment in the island nation, endangering the national security of India. As a country with massive population and the regional hegemon of South Asia, and also a country with future super power ambitions, India will have a closer eye on the Sri Lanka's external relations. If Sri Lanka move towards the Chinese sphere of influence without addressing the interest of India, Sri Lanka can experience the same kind of treatment it received from India in 1980s. India can always use the Tamil political issues in Sri Lanka, with the backing up of Tamil Nadu political influence to put pressure on Sri Lankan politics. In this background Sri Lanka has faced with a dilemma to balance the geopolitical interests of China and India. It seems Sri Lanka is faced with an unavoidable geopolitical paradox that will bring lots of challenges and opportunities to the island nation in the 21st century. Sri Lanka should



have a strategy for 21st century to not to antagonize the regional hegemon India and to gain opportunities from both China and India.

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# DYNAMICS IN CYBERSECURITY: CHALLENGES TO SRI LANKA'S NATIONAL SECURITY

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**Abstract** - Technological developments in today's world which take place annually, make technology accessible to individuals and communities that were previously not able to access it. The advent of mobile technology, its accessibility and affordability has enabled its penetration to all walks of society. This has therefore even empowered non-state actors and terrorist groups, which increases the threat individuals and states face.

The objectives of this study are to examine whether Sri Lanka is prepared to face threats that could penetrate the country via the cyber domain and to illustrate what mechanisms the country needs to take to overcome these threats to national security. The methodology undertaken for this research is qualitative in nature, with primary data constituting of government policy documents, agreements and legal documents. A series of in-depth interviews too were conducted with professionals in the cybersecurity and legal spheres. Secondary data such as news clippings from newspaper articles, reputed web articles, journal articles and statistics from both the Department of Census and Statistics, Sri Lanka and the International Telecommunication Union too were utilised for this research. The study thus provides an assessment of the country's cyber security preparedness.

In conclusion, Sri Lanka needs to improve its legislature to implement the international treaties it is signatory to, as well as, empower its Armed Forces so that they are capable of assessing threats in the cyber domain and countering them. Furthermore, the country which is in the process of drafting a cybersecurity policy needs to identify mechanisms for implementation or a body that will monitor it.

**Keywords** - Cybersecurity, National Security, Sri Lanka

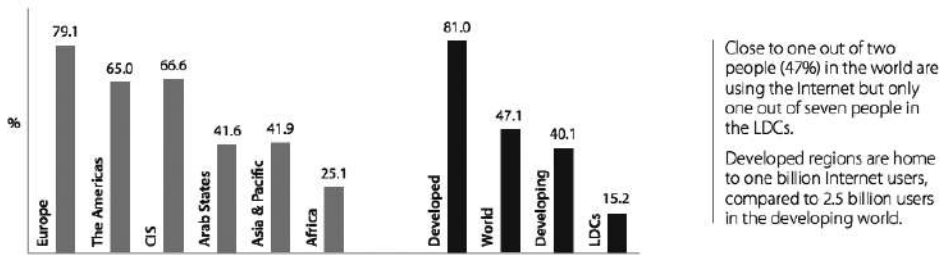
## I. INTRODUCTION

The world is witnessing an exponential growth in technology. Technological developments take place annually, making technology accessible to individuals and communities that were previously not able to access it. According to the International Telecommunication Union (ITU) 47% or approximately one out of two people in the world are using the Internet (2016, p.4). Mobile technology is penetrating every nook and corner of society due to its affordability, thus enabling even non-state actors and terrorist groups to make use of it.

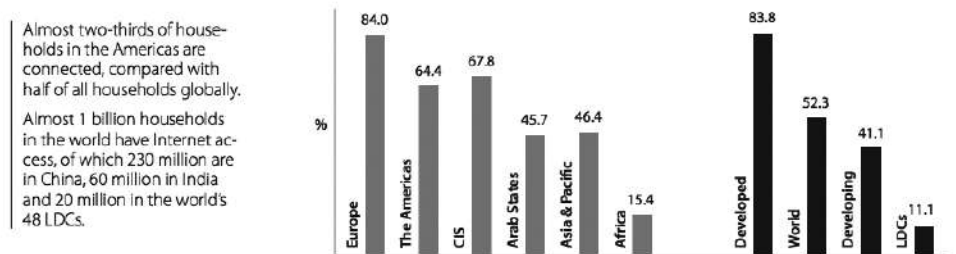
Accessibility and affordability, thus increases the threat individuals, states and companies face. But it should also be noted, that even though technology is accessible, there are an equal number of the world population who still do not have access to this convenience and connection. According to Director of the ITU Telecommunication Development Bureau - Brahima Sanou, "over two-thirds of the population lives within an area covered by a mobile broadband network and that ICT services continue to become more affordable" (International Telecommunication Union, 2016, p.1).

# THE DIGITAL DIVIDE IN 2016

Percentage of individuals using the Internet



Percentage of households with Internet access



Source: ICT Facts and Figures 2016, p.4.

As of 2013, the number of Sri Lanka's internet users was recorded as 21.90% of the total population, which is approximately a six percent growth from the previous year (International Telecommunication Union, 2014, p.1). Taking this growth projection, it can be understood that within a few years, half of the country's population will be connected to the internet, as a result, to the entire world. Therefore, with these statistics and growth projections under its belt, it is crucial for Sri Lanka to contemplate on enabling national security by protecting itself from non-traditional security threats such as cyberterrorism and cybercrime.

Thus, the primary objective of this study was to examine whether Sri Lanka is prepared to face threats that could penetrate the country via the fifth domain of warfare, i.e. the cyber domain. The secondary objective was to illustrate what mechanisms the country needs to take to overcome to face these threats to national security. Therefore, towards this end, the paper recommends policy initiatives and legal mechanisms that can be implemented to overcome this shortcoming.

The methodology undertaken for this research is qualitative and exploratory in nature, with primary data constituting of government policy documents, agreements and legal documents, interviews with officials from the Armed Forces, the civil and diplomatic services in addition to speeches and strategy documents.

The research also utilised information gathered during workshops and panel discussions on Cybersecurity in Sri Lanka. Further, the research utilised secondary data such as academic publications, newspaper articles, reputed web articles, journal articles and statistics from both the Department of Census and Statistics, Sri Lanka and the International Telecommunication Union. The study thus provides an assessment of the country's cybersecurity preparedness and undertakes its analysis via the realist notion of power.

Towards this end, the research utilised both the PESTLE, i.e. politics, economic, social, technological, legislation and environmental, and STEEP, i.e. society, technology,

environment, economy and politics, analysis tools to evaluate cyber security challenges to Sri Lanka.

An understanding of concepts such as cybersecurity and its correlation between cybercrime is required as these will be drawn on to explain the salient points of this paper. It is equally important to comprehend the concept of national security, as the main argument of this paper is based on the threats faced by Sri Lanka at present and a foresight on the future threat perception.

### A. Cybersecurity

The term cyberspace was coined by William Gibson in 1984 with reference to the internet and other networks, which proceeded to the prefix 'cyber' being used with phrases like 'crime' and 'security' (Fernando, 2016a). According to Jayantha Fernando, "cybercrime is not defined in legal conventions or treaties" (2016a), this definitional shortcoming leads to difficulties in implementing proper policies to curtail the occurrence of internet based crime and violence.

According to the International Telecommunication Union, cybercrime can be defined in both a narrow sense (computer crime) and a broad sense (computer-related crimes). The narrow sense defines cybercrime as an illegal activity "that target the security of computer systems and the data processed by them" (2012, p. 19). In the broader sense, cybercrime refers to "any illegal behaviour committed by means of, or in relation to, a computer system or network, including such crimes as illegal possession and offering or distributing information by means of a computer system or network" (International Telecommunication Union, 2012, p.19). Further, it can be simply termed as acts that harm the security and privacy, data and information of individuals, organisations or states. These crimes are various in nature such as hacking; phishing; harassment via e-mails, social media such as Facebook, Twitter etc.; e-mail spoofing; cyber trespassing, cyber-squatting, malware transmission; violations to Intellectual Property; crimes against government; cyber terrorism; crimes against society at large and financial crimes (Fernando, 2016a). This illustrates that cybercrime encapsulates a broad range of activities which are both illegal and harmful to the victim.

The United States Department of Homeland Security (DHS) views cybersecurity as illegal activities that undermine the safety of the cyberspace by targeting its vulnerabilities. It further defines that these threats can

be either physically or technically executed by either persons skilled in information technology or nation-states (2016). Activities that can be highlighted as threats against cybersecurity are related to "...steal[ing of] information and money ...developing capabilities to disrupt, destroy, or threaten the delivery of essential services" (United States Department of Homeland Security, 2016). The DHS further adds that a wide variety of traditional crimes related to child pornography, banking and financial fraud and intellectual property violations are now being committed via the cyberspace (2016).

It needs to be understood that cyberwarfare is largely connected with information warfare. According to James Adams, information warfare can be categorised into three definite areas. They are, "...perception management where information is the message, systems destruction where information is the medium, and information exploitation where information is the opponent's resource to be targeted" (1998, p. 17). This definition showcases the enormity of the problem at hand and the critical importance of cybersecurity.

Cybersecurity is seen as increasingly necessary and mandatory for a country due to its ability to organise and conduct traditional threats via the cyberspace, as well as because it can harm the bilateral relations between countries via its various illegal activities. Security in this space is vital as the next battle space will be determined by bits and bytes, not bullets (Adams, 1998, p.14).

### B. National Security

The legal definition provided by US Legal refers to national security as "...the protection of a nation from attack or other danger by holding adequate armed forces and guarding state secrets." The term entails within itself other aspects of security such as economy, energy, environment, military, natural resources and politics (US Legal, n.d.). This shows that these are areas of concern for Sri Lanka when seeking to protect its national security in the cyber domain. Not only does the term emphasise that it is the foundation of freedom and prosperity within a nation, it also underscores sovereignty. Papp and Alberts define national security as "... the protection of a state, its territories, and its peoples from physical assault by external forces, as well as the protection of important state economic, political, military, social, cultural, and valuative interest[s] from attacks emanating from foreign or domestic sources which may undermine, erode or eliminate these interests, thereby threatening the survival

of the state” (2000, p.245). This illustrates that in the future Sri Lanka cannot only be mindful of its physical borders, but has to be conscious of its virtual borders as well. The duo discuss about both military and non-military means that are utilised to protect and safeguard national security (Papp and Alberts, 2000, p.245). It is thus clear that the concept of national security is broad and that it has no clear and precise boundaries. However, factors such as wealth, geography and military force affect and influence this broad concept.

From a realist and neo-realist prism, national security can be defined as maintaining or safeguarding the state's elements of power in the fields of military, economy and politics (Waltz, 1979). Furthermore, Buzan describes security as “...the pursuit of freedom from threat and the ability of states and societies to maintain their independent identity and their functional integrity against forces of change which they see as hostile” (1991, p.432).

The national security policy (NSP) of a country is the framework document which explains how a country will safeguard its citizens and borders from internal and external threats. According to the Geneva Center for the Democratic Control of Armed Forces (DCAF), an “NSP has a present and future role, outlining the core interests of the nation and setting guidelines for addressing current and prospective threats and opportunities” (2005). It is also the policy document in which actors that safeguard national security are described in. Therefore, a National Security Policy performs an important role in safeguarding the national security of a country.

## II. CHALLENGES TO SRI LANKA'S NATIONAL SECURITY

It must be noted that non-traditional security threats from the cyber domain or information warfare is a very recent security challenge to Sri Lanka as the island was facing threats from the traditional spheres up until the first decade of the 21<sup>st</sup> century. Even though this phenomenon is relatively new to the South Asian country, it has been a problem worldwide since at least the end of the Cold War, when a fundamental revolution in warfare occurred (Adams, 1998, p.14). For developed countries like the United States “information warfare was already a reality” by the end of the 20<sup>th</sup> century (Adams, 1998, p.14).

Many businesses have gone online in Sri Lanka and even government institutions have implemented e-governance

in an attempt to create more access and convenience to the public. Therefore, the vulnerability of businesses and individuals to attacks is increasing and would continue to increase in the future with the increased move to digital platforms. “Businesses ... and societies have become networked by means of ICT,” stated Minister for Telecommunication and Digital Infrastructure Harin Fernando at the third annual Cyber Security Summit (Illanperuma, 2015). He further stated “within this context, cyber security plays a key role and should be regarded as the highest priority, with its power to potentially paralyse an organisation as well as play havoc with people's lives.” This showcases that the Sri Lankan government has identified the threat the country faces within the cyber domain.

The fact that unauthorized actors can come and establish themselves in Sri Lanka is worrying. It is equally alarming that illegal money can enter the country to be transferred to other global actors. It is advantageous that Sri Lanka managed to identify “...a dubious NGO ... that tried to sneak in millions of US dollars stolen by Chinese hackers from the Bangladesh Central Bank...” (Samath, 2016). Instances such as this are causes for concern for Sri Lanka's national security, as it undermines the country's financial capability.

According to Abhaya Induruwa, “[c]yber threats are growing in intensity and scale. We've seen significant breaches at government agencies and in private businesses...”, a situation he claims has brought about a lot of awareness among the layman, in comparison to before when knowledge of threats from the cyber domain were restricted to the knowledge of the IT professionals (Ceylon Today, 2017). Sri Lanka was extremely fortunate to have witnessed only one attack from the WannaCry Ransomware attack that took place in May 2017 (EconomyNext, 2017). However, this does not alleviate the possibility that Sri Lankans could be the victims of far greater a security threat.

When analysing Sri Lanka's cybersecurity challenges according to PESTLE, it can be understood that there are direct threats to the country's political, economic, social and technological spheres. It also poses absolute threats to the country's legislation, as it will require new legislation relevant to the Sri Lankan context to be prepared in order for the country to face these new challenges in the fifth domain of warfare.

According to Clausewitz, ‘war is a mere continuation of politics by other means’, which showcases that various

political goals can be brought to action even via the cyber domain using it as a means to cause discomfort and harm to various segments of society, be it the political hierarchy, businesses, military or even the ordinary citizen. As per Thomas Rid, there might be economic repercussions in a society that is highly networked, even if the attack was not meant to be violent in nature (2014, p.410).

As much as wars are fought using conventional weapons, a majority of them are now using modern technology to ensure communication within the systems (Adams, 1998, p.17). Thus, the functioning of systems would depend on for example modern microprocessors. Therefore, despite the common understanding that a cyber-attack would primarily harm the information systems and financial sector of the country, little attention has been paid to the damage that can be derived from such an attack on modern military equipment. As stated above, wars are intrinsically connected with politics, as all attacks are politically motivated. Hence, it is important to understand that Sri Lanka's conventional military hardware too are at a risk of attack as much as its networked infrastructure.

### III. MECHANISMS TO OVERCOME CYBERSECURITY CHALLENGES

According to William Lynn, "Although cyberspace is a man-made domain, it has become just as critical to military operations as land, sea, air and space" (Rid, 2014, p.408). Therefore whatever mechanisms Sri Lanka is taking, attention also needs to be given to empower the Tri-Forces to face this threat. As much as the Sri Lanka Computer Emergency Response Team [SL|CERT] is capable of countering certain threats and creating awareness among the public about security threats from the virtual domain (Palliyaguru, 2015) such as with the WannaCry Virus, it is equally important for the armed forces and police to be equipped with the know-how to counter future security breaches.

Sri Lanka became a signatory to the Budapest Convention or the Convention on Cybercrime in September 2015 which was drafted by the Council of Europe. This convention looks at addressing criminal activities online. Prior to this, Sri Lanka enacted specific legislation on cybercrime via the Computer Crime Act 2007. It further became signatory to the United Nations Convention on the Use of Electronic Communications in International Contracts in 2015.

Induruwa, a pioneer in Sri Lanka's information and communication technology (ICT) industry stressed on "...the concept of enhanced public/private information sharing and developing standards, and crafting a cybersecurity framework for Sri Lanka that addresses risks across government and industry" at The Cyber Security Forum held in July 2017 (Ceylon Today, 2017). He further highlighted that a cybersecurity framework should facilitate economic growth and create an enabling environment for innovation.

It was observed during this study that even though Sri Lanka has ratified numerous international treaties, it does not have an officially recognised national cybersecurity policy to implement internationally recognised cybersecurity standards. This is an area the government and lawmakers need to look into as implementation of laws and policies are essential in curtailing threats to Sri Lanka's national security. The ITU too has observed this lacuna in its 2014 report which states "Sri Lanka does not have any officially approved national (and sector specific) cybersecurity framework for the certification and accreditation of national agencies and public sector professionals." The researcher learned that while the Sri Lankan Armed Forces have initiated several mechanisms towards securing their virtual borders, the present government is keen on implementing a National Cyber Security Agenda inclusive of a Cybercrime Framework with the objective of ensuring trust and confidence for electronic transactions through legislative and policy measures (Fernando, 2016b; Illanperuma, 2015).

According to a former Commander of Sri Lanka Army, the LTTE might not be the only non-state actor that is interested in attacking Sri Lanka (2011). Therefore, having recognised that information warfare or cyberwarfare is an actuality even for a small state like Sri Lanka, it is important for Sri Lankan authorities to assess the vulnerability and determine from where the country's virtual borders would be most vulnerable to attack.

However, irrespective of the method followed in ensuring threats to Sri Lanka from the cyber domain are mitigated, these efforts need to not only be a whole-of-government approach, but a multi-stakeholder approach where both the public and private entities come together to address this very current problem.

## IV. CONCLUSION

When Sri Lanka's cybersecurity is applied to the 'STEEP' model, it indicates that the country will face immediate and long-term threats to its national security due to the threats posed to the technological realm which will also trickle into the economic and political spheres. According to Buzan, security needs to be viewed from a comprehensive approach, therefore, enabling security in the cyber domain is important for Sri Lanka to ensure other elements of its national security are safeguarded.

Towards this end, there are many steps Sri Lanka has to take to ensure the country's political, economic and technological spheres are safeguarded. One of the key elements in this regard is to initiate local legislature to implement the international treaties Sri Lanka is signatory to. Moreover, measures need to be taken to empower Sri Lanka's Armed Forces so that they are capable of assessing threats in the cyber domain and countering them.

In conclusion, Sri Lanka needs to assess its vulnerability to determine what steps need to be taken in preparation of such threats. Further, it is necessary for Sri Lanka to initiate a multi-stakeholder approach to its conceptualisation of addressing cybersecurity threats. Towards this end, it is essential to engage with the Armed Forces and the Police, the public sector and the private sector in formulating a National Cyber Security Policy. Sri Lanka has to strengthen its law enforcement capabilities in the cyber domain by empowering a specific body, thus ensuring stringent measures are taken towards the implementation of such laws and frameworks that are enacted.

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# TRANSITION OF ACCORDANCE: THE NEXT STEP OF INDIA - SRI LANKA ECONOMIC STRATEGY

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**Abstract** - Bilateral relationships of Sri Lanka with its big brother, India was old as the literal history of both countries. Each time the foreign policy cogency, external influence and the domestic political forces of both countries played a vital role in implementing and lashing these agreements. The efficiency of these economic partnerships affected to the development of each other in either good or bad means, but these fluctuations hadn't affected to enduring further agreements. With Prime Minister Modi's neighbourhood first policy, best example was the very recent framework agreement, Economic and Technology Cooperation Agreement (ETCA) which was in the process of finalizing, came out as a result of the discussion of Prime Ministers of both countries. The approval of the framework by both countries had arose the ill-acceptance of the public; specially the working sector of Sri Lanka. However, a separate chapter in Comprehensive Economic Partnership Agreement (CEPA) ) which was in the process of finalizing, came out as a result of the discussion of Prime Ministers of both countries. The approval of the framework by both countries had arose the ill-acceptance of the public; specially the working sector of Sri Lanka. However, a separate chapter in Comprehensive Economic Partnership Agreement (CEPA) touches the grounds of intellectual property, high technological innovations, technicians and guidance, exchange of technology of both countries was the most significant point that changes this agreement from. Therefore, Sri Lanka's target should be achieving a fair share through this agreement. The aim of this study was to examine whether the content of this ETCA was favourable especially to the Sri Lanka's economy; how it was favourable to upsurge the economy and strategies and mechanisms proposed by both countries. This is an explorative qualitative study done by interviewing bureaucrats, diplomats and field

experts of economy and using previously analysed data gathered from Indian High Commission of Sri Lanka. By reviewing and comparing the above collected data this essay has come up with the conclusion that the proposed system must be based on significant, on the rates of foreign direct investments in Sri Lanka. Since, it was in nature that the bigger country always achieved the highest advantage, but in any agreement both parties should be satisfied.

**Keywords** - Bilateral Relationships, Economic Partnership, Mechanism, Transparency, Intellectual property

## I. INTRODUCTION

The political history of both countries; India and Sri Lanka provides adequate illustrations of series of economic partnerships that both countries had. It is fairly factual to say that some agreements has given a real benefit subsequently some agreements were not that efficient for the economic development of Sri Lanka. The fact which shouldn't underestimate is that this each agreement came into achievement from a political or diplomatic relation that two leaders of each country shared. Concerning to the present context, with India's neighbourhood first policy both countries are in the process of finalizing the recent agreement; Indo-Lanka Economic and Technology Agreement (ETCA) framework and to have final agreements in place for signing by Indian Prime Minister Narendra Modi and Prime Minister Ranil Wickremesinghe.

This framework agreement cause continuous disagreements came out from the various sectors of the country which signs that there could be a touch of

inappropriate is going on through the process of this agreement. It is true that no country can survive in the current world arena without being connected to other each other. This inter-dependency has already become a part of the world economy and it has a greater impact to its partner-states. So as, Sri Lanka should enter into the world economy through agreements because owing of last few years the position Sri Lanka had in the world economy has loosen its tights and other regional developing economics have taken that place. Due to that 1.0% share that Sri Lanka owned in the world economy has deduced to 0.045% according to the current recordings. The argument is that, it does not mean any country should enter into bilateral or multilateral agreements because they are inter-dependent. Theoretically any agreement gives equal benefits to both parties and that is the reason countries should not restrained agreements. But it is necessarily important to examine whether the core content of that particular agreement is good for the future of the country or not. The Sri Lankan condition should be the same in that circumstance.

#### **A. India-Sri Lanka Economic Partnership History**

Scrutinizing the recent economic partnership of India and Sri Lanka, which has closely two decades of history, gives more negative results than good achievements to Sri Lanka. The first agreement is Indo-Sri Lanka Joint Committee in Economic Corporation in 1968. This agreement remained stagnant for much of the following two decades. India-Sri Lanka Free Trade Agreement (ISFTA) which came up with the aim of advancing trade relations of India at the same time meet Sri Lanka's import needs signed in 1998 and entered into force on 1st March 2000. It covers only trade in goods in duty free access (zero duty) or duty preferences which do not come under the negative list. One of the objectives of the ISFTA as stated in the agreement is "to contribute in this way, by the removal of barriers to trade, to the harmonious development and expansion of the world trade." (India, High Commission of India, 2013, p.09). But after the Free Trade Agreement (FTA), India imposed non-tariff barriers preventing Sri Lankan products from entering the Indian market and this dispute settlement mechanism couldn't make any effectiveness regarding this situation.

## **II. METHODOLOGY**

The study design is an explorative qualitative study which was done by interviewing bureaucrats, diplomats and field experts of economy of both countries; India and Sri Lanka

and using previously analysed data gathered from Indian High Commission of Sri Lanka.

Further, the study analysis was purely based on comparing the opinions of the field experts and authorized and previously analysed data. The comparison was done by complete step aside of political reasons and background. It was mainly focused on economical background and the strategical importance of this agreement.

## **III. REVIEWING THE ISFTA AGREEMENT**

Reviewing the India-Sri Lanka Free Trade Agreement (ISFTA), it leads to two significant conclusions; the first one is, after the agreement, imports of Indian goods have highly increased. In 2014 it was US\$ 4023 million. But Sri Lankan export to India takes a very few amount of US\$ 625 million. Compared to India's export to Sri Lanka this is very small amount. The second one is, Sri Lankan export to India after 14 years still remaining in a lesser value. For an example Sri Lankan Export to USA takes about 24% and to UK 10% without any bilateral agreements. But to India it indicates as 5.6%. Exports out of Sri Lanka are listed as US\$ 0.6 billion, the imports from India are moving a US\$ 4.3 billion and as a ratio it is 7:1 in favour of India. This economic gap occurred because of not releasing Sri Lankan goods due to non-tariff barriers. This factor is very crucial point of discouraging local manufacturers and entrepreneurs like DSI and companies, Natures Secrets and who had unpleasant experiences like Ceylon Biscuits.

## **IV. INDIA'S EAGER TOWARDS ETCA**

Besides India has accept the fact that most of the trade activities took place within last few years happened outside the Free Trade Agreement (FTA) and furthermore Indian sources mentioned that through ETCA, India's notion is to bring all those trade activities which are happening outside the FTA to get into the terms of the framework agreement. The reason why India always wants to keep every trade activity into the terms of the agreement rings the bell that these framework terms have a huge benefit to India's economy. It is a distinguished dynamic that any economic agreement that has equal terms which is going to happen or happening between two uneven powers has always been greatly profitable to major economic power country. Sri Lanka's situation is also the same. This asymmetry

between the two countries was duly accommodated by recognizing the principle of Special and Differential Treatment (SDT) for the small country, a “win-win” situation could be worked out. But relating to the reality that principle existed as a hallucination. The argument which can bring up here is that if this principle of STD was effective; then there is no point of moving to a new bilateral agreement with a new name. Since both countries has decided to move to a pristine agreement yet haven't mention a word about Special and Differential Treatment in the framework gives a clue that either Sri Lanka or India hasn't compared India-Sri Lanka Free Trade Agreement (ISFTA) with ETCA framework. Further, Indian sources have confirmed this clue.

But regardless the larger share of the benefit, Sri Lanka should have the competence of possessing a reasonable share of the benefit. Otherwise the rumour that spreading saying this framework agreement is a trap for Sri Lanka can be a real. The problem is how Sri Lanka is handling such sensitive matter if Sri Lanka is in a hurry to get into this ETCA agreement. To that a proper mechanism and a proceeding is necessary which is the area Sri Lanka hasn't touched yet. Without having any clue or strategy of making a profit out of a bilateral agreement, signing one can lead to a great economic catastrophe of Sri Lanka.

## V. STUDY OF THE RECENT PROGRESS OF ETCA FRAMEWORK AGREEMENT

ETCA framework agreement which has already made a huge repartee in the society has mentioned of its few chapters as Basic fundamentals, Early Harvest, movement of natural person, Technological Corporation and other amenities. Approaching towards the ETCA framework agreement; the viewpoint that can ascertain is that Sri Lankan government is not ready to be transparent or give any clue about the framework agreement of ETCA to the public which inevitably ascended the public suspicion. The 19th Amendment bill tries to give the access to right to information, yet the Sri Lankan government being suspicious, it is reasonable for the public to show their denounce and ask for transparency of the framework agreement which two countries has agreed so far. The question is why the Sri Lankan government is being secretive in this framework agreement which is not finalized at least. For that the hypothetical conclusion which can come up is that both countries has disagreements because

still India hasn't showed any class of positive or negative reaction towards the framework agreement Sri Lanka has given to them in Sri Lankan side.

Anyway the Sri Lankan government is saying that ETCA is entirely different from Comprehensive Economic Partnership Agreement (CEPA) yet the Indian government has accepted that ETCA as a one step ahead from CEPA by correcting all mistakes that occurred through CEPA agreement. This contradictory, that two governments having two perspectives regarding the same matter leads to the conclusion that one government is not being realistic. Furthermore sources of the Indian High Commission of Sri Lanka stated that signing of the ETCA agreement is planning on the first three months of 2017 not in the middle of 2016. But the Prime Minister Mr. Ranil Wickramasinghe stated that ETCA agreement will be signing in the middle of 2016. But the Indian High Commission doesn't make any opinion relating to Sri Lankan government's statements which is again suspicious enough to up bring public incongruity. The assumption that can arrive is that Sri Lankan government is in a haste to implement this agreement although the Indian government wants to do it in the approved manner. If so, the Sri Lankan government is in an urgency it is hard to be certain of that the terms both countries accepted to agree could be favourable towards Sri Lanka as government. But it is hard to predict the future of the agreement because it is in the framework stage now. Nevertheless what is necessary is that signing the ETCA agreement favourable to Sri Lanka.

As a coin has its two sides; the ETCA framework agreement has some productive benefits too. From chapter two of the framework agreement the first priority has given to early harvest by both countries. Although Sri Lanka is earning profits from India-Sri Lanka Free Trade Agreement (ISFTA), non-tariff barriers can make difficulties in entering to different states of India. Concerning this factor, India has brought a new Goods and Services Tax bill to the Indian parliament to make a uniform tax rate in India's each state government and to reduce the delay in transporting merchandises by discussing both countries about a joint mechanism of checking goods entering to each country through a mutual agreement. Besides, according to the framework agreement, India's negative list is planned to reduce but Indian sources haven't mentioned anything about Sri Lanka's negative list which is about 1220 already. If these planning are practically going to take place, then it will be a huge sustenance for the mutual understanding of both countries but the issue in here is these plans need

a better mechanism with proper understand of both countries and which is not here at the present situation. Promotion of joint ventures, draw much foreign direct investment (FDI), tourism, custom, e-commercial activities, industries are the same criterias which already have in ISFTA but failed many times. Citing failed criterias to a new agreement can debilitate the agreement and Sri Lanka should find new ways to achieve these goals rather than relying on the same failed terms. Another factor is that ,before allowing India's to tough Sri Lanka's job market it is important to seek whether Indian job market to Sri Lanka is achievable or not. Because 7% means 37 million of the Indian population is unemployed and that percentage surely increase the Sri Lankan unemployment.

## VI. TECHNOLOGICAL CHAPTER OF ETCA

Chapter V of the ETCA framework agreement which gives the special reference to the technological corporation of both countries have included vital and important Articles to the agreement. It is fair to say that this chapter is the most important part of the framework agreement and it can guide both countries to an innovative approach. The chapter which openly deals with the intellectual property of both countries and Article II subsection (a) gives access to technological guidance relating to experiments which leads to economical purposes. Subsection (b) mentions about high technological innovations, exchanging technology and inspirations of experiments that will encouraged from this agreement. Having a separate chapter in an agreement about something that has access with modern world is very much important. But the default in here is the framework agreement hasn't mention any mechanism or future mechanism they expect to imply to stimulate the technological corporation and haven't mentioned about the safety and the guarantee of protection of resource persons. Without having a sound knowledge and fully understand about the mechanism for any country it is dangerous and unfavourable to deal with intellectual property.

## VII. LAW REFORMATIONS NEEDED WITH ETCA

Indian legal system is in a much more advanced step comparing to the Sri Lankan legal system when it comes to bilateral agreements because India has signed many more detailed economic partnership agreements

with countries like China, South Korea and Singapore. Therefore India has standardized its legal system and regulatory framework. Nevertheless in that manner Sri Lanka has a long process to continue and it is doubtful whether the Sri Lankan government has even considered about this fact up to now. Besides the fact that Sri Lanka is in lack of professional authorization bodies to sign mutual recognition agreements, there are approximately 30 other pieces of legislation which need to be amended to give effect to trade in services between two countries. These laws need amendments from Immigration and Emigration Act, labour laws, banking laws, Inland Revenue Act, business registration laws, insurance laws, the Medical Council Act etc.

## VIII. TAMIL NADU INFLUENCE IN INDIA-SRI LANKA ECONOMIC PARTNERSHIP

On the contrary Tamil Nadu politics has always played a very crucial title role in India- Sri Lanka partnership agreements. Enlightening that fact further, Prime Minister Modi's proposal of Goods and Services Tax Bill (GST Bill) which Indian government trying to pass regarding the tax they imposed on Sri Lankan harvests entering to Indian market is still wedged due to the Tamil Nadu election and their political dilemma. According to the prior experiences Sri Lanka has, it is very hard to come to a conclusion that Tamil Nadu state government will show a favourable concealment in this scenario. Therefore it is clear that when it comes to the Indian situation, one powerful state government can make a momentous change in the whole governmental decision making process and change won't be favourable towards Sri Lanka.

## IX. RESEMBLES IN ETCA AND ISFTA

As stated before, Sri Lankan government has specified that ETCA agreement is unlike any other agreement Sri Lanka had with India but relating the major sections of the ETCA framework agreement with India-Sri Lanka Free Trade Agreement (ISFTA) there are resemblances which can clearly identify. Both has Dispute Settlement Mechanism; in Article II of the chapter XII of ETCA framework and Article XIII of the ISFTA have resembles. Terms of the Dispute Settlement Mechanisms proposed to

India by Sri Lanka has similarities to ISFTA but the fact is that Dispute Settlement Mechanism of ISFTA ended as a failure and India also accepted that dispute settlement mechanism is not functioning in a proper manner. Then the next argument come up is that even though there is a noble apex chamber, why it did not function as expected. The best example is non-tariff barriers imposed by India to Sri Lankan products after FTA. It reduced nearly US\$ 28 million in 2011 to US\$ 7 million in of the Sri Lankan economy. In this situation it is clearly high-lighted that Sri Lankan government is acting irresponsible and it is Sri Lankan government's responsibility to contemplate all those factors in outlining a new framework agreement. Therefore the purpose behind including this same mechanism to the new Framework agreement is a question.

## X. ACCESS TO WORLD TRADE ORGANIZATION

General Agreement on Trade and Services- (GATS) the international convention which governs the trades in services must be taken into the count in bilateral agreement and all the WTO members are instantaneously members of GATS. Even though Minister Malik Samarawickrema specifically remarks that ETCA will be based on the WTO agreement as well as 'other such' multilateral agreements GATS hasn't been cited in the ETCA framework agreement. The reason why GATS has not been specifically mentioned in the ETCA framework agreement is obvious because opening the trade in services to India has become a contentious issue and the government would like to moderate it. Clarifying in advance, the GATS guidelines stipulate that after a state has accepted specific commitments to open certain service sectors to the partner state, that state is prohibited from applying any new licensing and qualification requirements and technical standards in that precise professional category. For that reason, according to the terms of GATS Sri Lanka has a backward regulatory framework for ETCA.

## XI. CONCLUSION

Evaluation terms of the ETCA framework agreement it is clear that Sri Lanka needs more foreign direct investments (FDI) and India being Sri Lanka's biggest partner in tourism can easily bring FDI to here. For that Sri Lanka must be more close to India as the closest neighbour. If Sri Lanka is planning on the huge step in economy, a

suitable legal system will be obligatory. Joint commissions and joint venture has always plays a significant role in any country's economy and Sri Lanka has to focus in that arena more. Before getting into any agreement, Sri Lanka should be more thorough with information on how foreign agreements of India are going on and according to that Sri Lanka has to make its economic plans. It is in nature that the bigger country always achieve the highest advantage, but in any agreement both parties should be satisfied.

## XII. RECOMMENDATIONS

- i. The issue must be addressed in a very sensitive manner and government should take necessary steps to solve the burning problems of manufacturers and entrepreneurs who had to face non-tariff barriers which will give some merits to the government at the same time confidence to the system to lead bilateral relations of both countries.
- ii. Reconsidering about including sections like section V of the chapter VII of ETCA framework agreement is necessary because it can leads to economical traps in future.
- iii. With the help of law implementing authority, policymakers and chambers; the government needs to have long term joint venture proposals and some export brands which can take easy access to the Indian market.
- iv. Having a diversity in exporting group of product categories rather than relying on few major products can reduce being exporters getting disappoint and meanwhile helps to have a constant flow of money towards the country.
- v. Keep a uniform duty rate with India as already proposed by early harvest mechanism and Sri Lanka should contribute its support to GST bill and meanwhile take necessary discussion rounds to keep away raw materials from adding to the negative list.
- vi. Take necessary actions to make ETCA agreement with accordance to WTO and GATS is also necessary because it can affect to the future of both countries in dealing with international arena.

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# AIR POWER: A RESPONSE OPTION TO COUNTER THE CHALLENGES OF SUB-CONVENTIONAL WARFARE DYNAMICS

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**Abstract** - Sub-conventional warfare refers to the grey region of the spectrum of conflict. Since inception the face of the sub-conventional warfare remains in a continuous transition due to the changing dynamics of technology, interests of state/non state actors, global/regional political status etc.

The unique characteristics of airpower such as height speed and reach empowered by flexibility, mobility and precision enables Air Forces to counter sub-conventional elements with an asymmetric advantage. Hence it requires timely reviewing of roles and missions ultimately lead to techniques and tactics with differing capabilities in dissimilar situations. Air power is offensive in nature. Conventional applications of air power can be improvised in dealing with sub-conventional elements such as surveillance and reconnaissance, providing bird eye view for decision makers, tactical air mobility and air strikes.

Usually sub-conventional elements emerge as a small group of insurgents commonly untrained and inexperienced, which later develops and expands up to near conventional forces by winning the popular support where they dominate. Nipping it in the bud is the best approach to eliminate such armed elements, paralyzing militarily where their roots are not deepened enough to withstand longer and heftier military encounters. For the betterment of the safety and security of the nation, at times command elements might need to take crucial decisions to launch kinetic air operations even with inevitable minute un-intentional damages. Air power strategy should be in line with overall strategy. Triumph of airpower against sub-conventional elements depends upon three main rudiments. They are Intelligence, technology and joint operational effort. This study proposes an option in designing airpower strategy in countering sub-

conventional warfare challenges.

**Keywords** - Airpower, Intelligence, Technology, Joint Operations

## I. SUB-CONVENTIONAL WARFARE

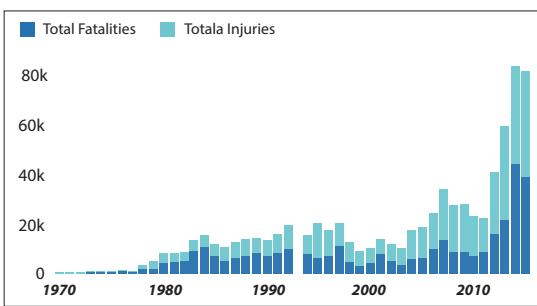
Sub-conventional warfare refers to the grey region of the spectrum of conflict. Basically any kind of armed encounter other than conventional warfare can be classified as sub-conventional warfare. However due to the broader and vague demarcation of this band of

Warfare it is practically difficult to provide a single definition which suits the full diversity of scenarios. No matter which term it goes by - civil disobedience, counter-insurgency, guerrilla warfare, insurgency, insurrection, internal security, revolutionary warfare, small wars, subversion, low intensity conflict, terrorism in the first decade of the 21st century is predominantly sub-conventional conflict (Kanwal, 2008). In this study author refers to the conflicts beyond organized violence and below direct military intervention of a state, with the will of challenging national interests define by the particular state as sub-conventional encounters.

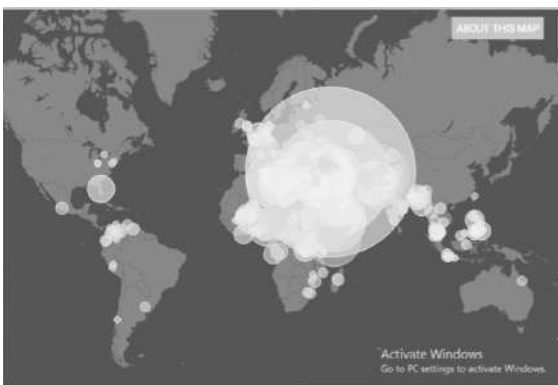
Irregular warfare is nothing new; it has been documented from rebellions in ancient times through to its prevalence in modern-day conflicts. Throughout this period, the methods of fighting have been broad, including guerrilla warfare, insurgency and terrorism (Glasson, 2014). From inception the face of the sub-conventional warfare remains



in a continuous transition due to the changing dynamics of technology, interests of state/non state actors, global/regional political status etc. Hence it requires continuous study in dealing successfully with the armed uprisings in different forms. Sub-conventional warfare has become latest phenomenon of the spectrum of conflict across the globe, forcing the militaries to be on the ball for the ever transforming scenarios. Following figures shows an increment of terror attacks from past up to now which indeed force us to predict the complexity of future conflict situations.



**Figure 1: Global Fatalities and Injuries from Terrorist attacks**  
 Source: National Consortium for the Study of Terrorism and Responses to Terrorism



**Figure 2: Terrorist Attacks in 2016**  
 Source: <https://storymaps.esri.com/stories/terrorist-attacks>

In addition to fourth dimension, the air, has brought speed, flexibility and dynamism to the modern battlefield while “unconventional war” has meant a non-linear battlefield with no front and no rear, with soldiers without uniforms

targeting combatants and non-combatants alike without observing Marquess of Queensbury’s rules of gentlemanly conduct (Ikram, 2002). The unique characteristics of airpower such as height speed and reach empowered by flexibility, mobility and precision enables Air Forces to counter sub-conventional elements with asymmetric advantage. Hence it requires timely reviewing of roles and missions ultimately lead to techniques and tactics with differing capabilities in dissimilar situations.

Usually these actors emerge as a small group of insurgents commonly untrained and inexperienced, which later develops and expands up to near conventional forces by winning the popular support where they dominate. Further in such scenarios the insurgents develop ties with extraterritorial elements in non-state and state nature in order to fulfill logistic needs, to acquire training and technological support and to exert politico-diplomatic pressure on the targeted state.

## II.ROLE OF AIR POWER IN SUB CONVENTIONAL WARFARE

Air power is offensive in nature. Conventional applications of air power can be improvised in dealing with sub-conventional elements. Since one size does not fit for all, undertaking of this exercise is challenging than it appears. This paper proposes an option for a strategic module in countering such elements. Air power provides essential asymmetric advantage in sub-conventional warfare. Outward show and the true capabilities of the sub conventional actors may vary from element-to-element. The state of affairs becomes multifaceted when these elements are supported by other state and non-state actors. Sri Lanka experienced such a complex situation when Liberation Tigers of Tamil Elam (LTTE) terrorists were supported by neighboring sub-state actor under the patronage of several state actors as well as globally spread number of non-state actors whom mounted a coordinated and combined threat.

### A. Surveillance and Reconnaissance

Aerial reconnaissance can play a major role along with ground and naval intelligence in detecting and tracking of insurgents/terrorists movements, activities, operating bases, hideouts, supply routes etc. Aerial photography and footages from manned or unmanned platforms would be utilized in this effort as experienced by Sri Lanka Air Force (SLAF) during anti-terrorism humanitarian

operations conducted during 2006-2009. However aid of sophisticated technology is needed in detecting and tracking of terrorists/ insurgents activities happening under thick jungle canopies and other terrain limitations which is beyond the traditional line of sight. If not modern terrorists/ insurgents who usually establish effective intelligence network which is capable of providing information regarding surveillance and reconnaissance upon them would make the entire aerial effort futile. Further these records can be utilized in generating post attack damage assessment reports.

### B. Bird eye view for decision makers

Aerial view provides decision makers a better understanding of the real-time situation and air power provides speedy options in dealing with the hostilities. These characteristics of airpower enable the command and control elements to monitor larger territories with fewer troops. Better informed special operations teams, ground intelligence agents, ground force commanders etc with aerial perspective have the advantage of making quicker and better decision in winning the situations. This attempt was tested by SLAF in anti-terrorism operations against LTTE during 2006-2009 which became a success.

### C. Tactical air mobility

Tactical air mobility by fixed wing and heli platforms enables concentrating required forces to required positions in shortest possible time allowing the states to telescope the impact of hostilities in a shorter time. Mobilization of troops by the means of ground and sea takes a lengthier time with compared to air. Being able to deploy required category of troops at shortest possible time is more effective. It enables mobilization of specialized troops in bolstering the impact of attacks initially and later other police, medical, food assistance in relieving affected civilians which aid in winning the favor of populace.

### D. Aerial Strikes

Air strikes on insurgents/terrorists are the last option available which can be executed under the political will when the situation is escalated. Employing air power alone or in support of ground / naval forces would minimize the damages and commitment of ground / naval troops. It is controversial that how ethical and legal to employ offensive force such as air power against a segment of state populace in such situation. However taxpaying citizenry expects security and safety by maintaining legal armed forces

against any threat which might arise extra-territorially or territorially.

One major tactic of insurgents / terrorists is blending with civil population which demands surgical accuracy in strike. Precision Guided Munitions (PGMs) would be an added advantage in meeting higher accuracy for such operations. Sound intelligence and real time target updates along with developed pilot skills would provide better results even without PGMs. Precision aerial strike which eliminated LTTE terrorist leader Thamil Selvam with non-precision aerial bombardment is a classic example for such operation.

## III.OVERALL STRATEGY

“War, once declared, must be waged offensively, aggressively. The enemy must not be fended off, but smitten down”

-Admiral Alfred Thayer Mahan-

Unlike conventional wars, sub-conventional conflicts tends to protract for a longer periods. Sometimes even for decades without seeing a clear end. Classic examples are Al-Qaida, ISIS, Mujehideens, Naxalites etc. Naturally these actors emerge as a small group of insurgents usually untrained and inexperienced, which later develops and expands up to near conventional force by winning the popular support where they dominate. Further in such scenarios the insurgents develop ties with extraterritorial elements in non-state and state nature in order to fulfil logistic needs, to acquire training and technological support and to exert politico-diplomatic pressure on the government. Successful insurgencies tend to have external political, diplomatic and military support, including for training and logistics, sanctuary in the supporting nation, and the ability to control some territory (Kanwal, 2008). LTTE terrorists started from a small untrained armed group and developed in to a near conventional force with separate armed units for ground, naval, special and air operations, with the blessings of neighbouring sub-state actor and state actors mediated by internationally spread non state actors.

In many cases there is a political end state that particular group of terrorists / insurgents might wish to achieve by unleashing the terror on public which indeed demand the quick attention and speedy response by the targeted state. Therefore it is a paramount importance that sub conventional battles are fought with holistic approach

covering military, politico-diplomatic and socio-economic factors alike.

Nipping it in the bud is the best approach to eliminate such armed elements, paralysing militarily where their roots are not deepened enough to withstand longer and heftier military encounters. Hence full intervention and genuine politico-military effort at early stages would provide more likelihoods of terminating the dispute. Provided that global, regional and domestic political affairs are dealt by the government and required liberty is given to the military components, will support in delivering an effective, efficient, stable and accelerated end state to the conflict.

National media also have a great role to play in manoeuvring the populace in favor of national will since modern sub-conventional elements sought the support of different breeds of media which are capable of moving the calculus in favor of their course by misleading the common public.

**E. Air power Strategy**

Air power strategy should be in line with overall strategy. Triumph of airpower against sub-conventional elements depends upon three main rudiments. They are Intelligence, technology and joint operational effort.



**Figure: Rudiments of Air Power in Sub-conventional warfare**  
 Source: By Author

It is an interdependent and integrated effort rather than autonomous operations carried out by individual agencies.

Sound ground/naval intelligence assisted by technology would facilitate air forces to deliver required air power against insurgents/terrorists on ground or on territorial waters. Air forces/air arms are bound to secure third dimension over land and over sea of the particular state. Maximum attrition with nil unintentional damages for a quicker end would be the mission.

Manned/Unmanned platforms can be utilized in coordination with ground/naval troops, intelligence units, and command and control elements. Aerial surveillance and reconnaissance will enhance the sensing quality and capacity of the intelligence sources. Aptitude of monitoring larger territories using fewer units is one of the greatest advantages. Inputs of aerial photography and footages would greatly aid in defining the territorial pattern of the terrorists / insurgents which is essential for the initiation of ground strategy.

“Of what use is decisive victory in battle if we bleed to death as a result of it?”  
 -Sir Winston Churchill-

Use of offensive airpower whenever possible would prevent needless damages to ground / naval troops. In the modern era of warfare, the Israelis have been the pioneers in the use of air and space assets to prosecute campaigns against non-state actors like Hamas and Hezbollah, even without committing ground forces (Ghose, 2010). Eliminating leadership, training centres, hideouts and supply depots could hamper large scale manoeuvres of insurgents/terrorists as experienced during last anti-terrorism humanitarian operations conducted by SLAF against LTTE. Especially eliminating leadership would have significant impact on change of course of the entire movement. Nevertheless aggressive use of airpower would exert both somatic and psychosomatic pressure on insurgents/ terrorists.

Available air assets would be utilized for strike, surveillance and reconnaissance, air mobility and other supporting operations. Further rigorous training can style pilots behind machines to deliver munitions with precision. Entire training process should include counter unconventional warfare strategies, techniques and tactics. Further especial training sessions focused on counter sub-conventional warfare operations should carryout in joint environment.

In intensified situations air defense threats by Short Range Air Defence Systems (SHORADS) becomes a highly likely

phenomenon. Liberty of employing air assets over intended targets would be affected by the confirmed /assumed Air Defence capabilities of the terrorists/ insurgents. LTTE managed to shot down several Heli/ fixed wing aircraft and badly damaged two fighters using shoulder fired Surface to Air Missiles and anti aircraft guns.

Protection of air assets need to be strengthened since limited air assets available would be more vulnerable and more decisive. Base dependency is another limitation which would be able make air force on knees if not properly protected like “Achilles foot”. Hence bases where air assets depend need to safeguard with maximum effort. Attack on own air assets would do great psychological damage apart from the physical damage upon own forces. Recent example from sub-conventional warfare is the LTTE attack on Sri Lanka Air Force Base Anuradhapura in June 2007 which destroyed/disabled more than a dozen platforms including key manned and unmanned reconnaissance platforms which incapacitated SLAF in surveillance and reconnaissance for a limited period.

**F. Sanctuaries**

Transnational sanctuaries play a key role in favor of terrorists/insurgents from onset with or without the consent of the particular. In the Greek Civil War (1946-1949), the Communist rebels enjoyed the use of sanctuaries in Albania, Yugoslavia, and Bulgaria (Ghose, 2010). Presence of kin state phenomenon paves way to more luxurious sanctuaries. Maritime nations find it more challenging to protect maritime borders than land borders. LTTE used to smuggle their needs through the means of sea using floating armories and from Thamilnadu. One assumption is that LTTE managed to smuggle heavy weapons and aircraft those they used during the conflict were by sea routes. Hence maritime air operations shall play a great role in support of naval operations against insurgency/terrorism.

**G. Realizing the inevitable**

One trend of modern sub-conventional warfare which terrorists/insurgents prefer to follow is to blend with the public and conduct operations behind the veil, which renders the direct military action against them. This is one of the key challenges in employing airpower in kinetic operations. However it is to be realized that even after careful planning with real-time intelligence and delivering the munitions with ultimate precision, un-intentional damages would be inevitable. For the betterment of the

safety and security of the nation, at times command elements might need to take crucial decisions to launch kinetic air operations even with minute un-intentional damages.

**IV.RUDIMENTS OF THE TRUMP OF AIR POWER**

Rudiments of trump of air power in sub-conventional warfare are as follows.

- Intelligence
- Technology
- Joint Operational Effort

Nexus between these three factors is vital. These three are inter related and mutually inter dependent.



*Figure: Connection between rudiments  
Source: Author*

**G. Intelligence**

Intelligence plays the vital role in peacetime. In war time intelligence lies at the heart of effective military operations, although it cannot compensate for poor tactical execution (Ghose, 2010). Sound ground/naval intelligence will be the first and foremost elements to be sensed about forming up of insurgents/terrorists movements. The intelligent questions to ask and answer are those that help identify the enemy’s nodes, processes, webs, intersections, and unions that produce, transport, or control combat power. Smart enemies will attempt to hide and defend these (Ikram,

2002). At the preliminary stage of the materializing most probably there would not be any air power requirement. Nevertheless whenever situation escalates, involvement of air power is essential. In intensified conditions air surveillance and reconnaissance can provide information to intelligence agencies which are gathered through UAVs and manned platforms.

Different intelligent agencies operating on the same cause territorially and extra-territorially needs to be integrated. Proper combination of Human Intelligence (HUMINT), Electronic Intelligence (ELINT) and Signal Intelligence (SIGINT) would provide better and real-time output for the strike forces to hunt down key hostile players and their grips which can greatly alter the cause of the conflict.

In Essence, airpower is targeting; targeting is intelligence; and intelligence is analysing the effects of air operations (Ikram, 2002). Battle Management Command and Control Center (BMCC) which was activated during anti-terrorism humanitarian operations against LTTE by SLAF is one of the classic examples for such institutions. Acting as ears and eyes which painted the targets for aerial strikes it played the pivotal role in integrating information and actions to achieve high operational success.

Proposed agencies are as follows in forming up for Intelligence Management and Air Operations Coordination Command and Control Center (IMAOC).

- |    |                              |   |                       |
|----|------------------------------|---|-----------------------|
| a. | Air intelligence             | } | Intelligence Services |
| b. | Ground intelligence          |   |                       |
| c. | Naval intelligence           |   |                       |
| d. | State intelligence           |   |                       |
| e. | Air assets                   | } | Civil state agencies  |
| f. | Ground troops                |   |                       |
| g. | Naval assets                 |   |                       |
| h. | Police                       | } | Civil state agencies  |
| i. | Boarder control              |   |                       |
| j. | Coast guards                 |   |                       |
| k. | Riot control units           | } | Civil state agencies  |
| l. | Command and control elements |   |                       |



**Operations Coordination Command and Control Center.**  
Source: By Author

Basic concept of this structure is that centralized command and decentralized execution. Real-time data link with aerial, ground and naval forces in coordination with command and control elements, such an institute can become the anchor point of network centric operations, dwindling the time between sensing to shooting which leads to operational success. Nevertheless airpower’s unique characteristics require centralized control by airmen to have the full use of it.

“Air warfare cannot be separated into little packets; it knows no boundaries on land and sea other than those imposed by the radius of action of the aircraft; it is a unity and demands unity of command”.  
-Air Marshal Arthur Tedder -

Further airpower is too expensive, being vulnerable to far cheaper and primitive anti-aircraft weapons and total dependence for its success rests on strategic and tactical intelligence. Intelligence need to assist in force protection.

**H. Technology**

Pace of the advancement of technology had marked ever high. Technology and airpower are integrally and synergistically related. Rapid advances in science and technology ensured that airpower has accuracy, speed and is difficult in countering, making it also more decisive in unconventional wars, unconventional warriors not having

**Figure: Proposed Intelligence Management and Air**

the resources to afford counter-measures or avoid being manipulated into providing conventional targets (Ikram, 2002). In order provide better ELINT and SIGINT it requires sophisticated equipment onboard which conduct surveillance and reconnaissance. Developed inputs from high resolution infrared images, high grade FLIR and thermal imagery and real-time footages would be able to locate and track mobile elements of insurgents/terrorists and pave way to strike forces to embark upon with precision. Conventional Information, surveillance, target acquisition, and reconnaissance (ISTAR) platforms could be utilized for a better outcome.

PGMs would assist in attacking targets with minimal un-intentional damage while accomplishing superior results. Sophisticated and secured data links required for the upgrading of network centric operational capability is essential which expand the effectiveness of data transferring as well as enhances the security against cyber threats.

Unlike in past most of the technology is accessible to individuals through internet. Further modern insurgents/terrorists use improvisation to have non-traditional but effective results. For an example, modern quad rotors which have long range and higher operational ceiling armed with sufficient explosives can be utilized to fulfil a hazardous purpose. An insurgent/terrorist with technical background would create equipment using the material available at local and online markets which can affect Electronic Warfare (EW) capability of forces. On Sept 11 in New York, an unconventional enemy crafted a commercial aircraft into unconventional airpower and made a major impact on conventional forces, conventional forces miserably failing to protect against unconventional means (Ikram, 2002). Hence it needs to be appreciate, technically advanced and militarily proficient adversaries in future sub-conventional warfare situations.

Further cyber-attacks would hamper most digital based network centric operating systems used by forces which can lead to operational inefficiency if not properly guarded. Therefore always being technologically ahead is to be considered as one of the prime objectives. Since the technology is un-confined, while taking the advantage of it, need to prepare adverse effects of the same by the hostile usage of it simultaneously.

### **I. Joint Operational Effort**

This is the most vital among the rudiments since it is the delivering segment of the entire process. Inability to hold

ground is one of the key limitations of airpower which require surface elements to complete the mission. Airpower can blow the door of its hinges allowing the soldiers to go in and engage. Unlike in conventional warfare it is difficult to predict what component of the military / non-military would serve better in differing sub conventional warfare situations. Also different stages of the conflicts will demand different components and different application of forces. The object of force application determines the form of force control. Destroying an enemy's will to resist only by air attack does not remain a vision anymore, which was proved in Afghanistan and so on.

Hence in most occurrences synergistic approach would successfully cater the demand of elusive and unpredictable nature of sub-conventional elements. Armed services along with other state agencies such as intelligence agencies, police, coast guards, boarder control etc should integrated and deliver the outcome through centralized command. It would permit delivering algorithms of air power in dealing with insurgents/terrorists. Airpower, when integrated with ground power and naval power, can bring a fight to its culminating point (Ikram, 2002).

Joint training exercises needs to be carried out frequently to build the cohesiveness of the agencies. Wherewithal of facing different scenarios should foresee and exercises should be planned accordingly to be better prepared for the ever transforming modern sub conventional warfare demands. The fundamentals of joint operations need to be slot in to the basic, advanced and continuation trainings. Afterwards the art of joint operations would be mastered through continuous joint operational training in different scenarios.

## **V. RECOMMENDATIONS**

1. To establish an institute for the management of strategic and tactical intelligence and execution of effective conduct of air operations in combination with agencies mentioned in Para IV. A. This center needs to be active irrespective peace/conflict.
2. Conduct separate research and development programs in view of countering sub-conventional conflict situations. Strategies, techniques and tactics can be formulated and tested. One of the key objectives should be being technologically ahead.
3. Slot in sub-conventional warfare segment in to the

syllabi of basic, advanced and continuation trainings and conduct joint training exercise regularly in coordination with research and development outcomes to build the cohesiveness, understanding and trust among different elements.

## VI. CONCLUSION

Diversity of sub-conventional warfare situations is countless. The nature of sub-conventional warfare is that no situation or opponent is likely to be the same. Overall pattern of terrorists/ insurgents change with objectives, ideologies, believes, place, time, topography, capability, capacity, opportunity etc. Therefore formulating the best suited version of the strategic framework should be done with updated details of the terrorists/insurgents in accordance with competencies and capacity of own troops and equipment. However the proposed strategic option would be utilized as the basic layout for the overall design. Nipping it in the bud will do minimal damages to all parties and will pave way to an accelerated end state.

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# THE INFLUENCE OF GLOBAL ISLAM RADICALISATION TO SRI LANKA

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**Abstract** - 'The Threat of Global Islam Radicalisation to Sri Lanka' is a paper submitted to the 10th KDU International Research Conference. This paper in its Introduction examines the background to conflicts in countries where Islam is followed as a religion and gives a historical perspective to the current conflicts in the Middle East. The Introduction identifies that the historical divide between the Sunni and Shia Islam sects have led to create deep rooted sectarian divide among these two Islam schools of thought. It also brings out the present beginning of this sectarian divide when the paper identifies four major contributory factors to the rise of present day conflicts in the Middle East and its spill over effects to other parts of the world. The paper hopes to inspire Sri Lanka's public servants and policy makers to gain more knowledge on the subject in order to be able to formulate effective counter mechanisms. This brings the reader to the research objective which is to find if Sri Lanka has a suitable national security and social framework to face this challenge.

The research methodology is qualitative and mainly based on secondary sources related to Islam radicalisation and best practices as counter measures. A definition of radicalisation and Islam militancy by Tomas Precht which could be adopted to suit any religious militancy has been cited in context of the paper. The paper discusses how the phenomenon of global Islam radicalisation affected Sri Lanka in two ways. Firstly, it has affected the Muslim community but not to the extent where rapid radicalisation has taken place to inspire violent or radical activity openly. Secondly, this phenomenon set in motion a wave of Sinhala Buddhist radicalisation leading to intimidation and targeted violence. The Sri

Lankan perspective gives insight to Islam radicalisation in Sri Lanka and the problems faced within the Muslim community. The paper also makes recommendations to counter the spread of violent radicalisation and also the necessity for regional and global cooperation to face this challenge. The whole of government approach or adoption of the concept of homeland security by strengthening cooperation between Government Departments and the Intelligence and Security Sector appear to be the key to deter this phenomenon.

**Keywords** - Radicalisation, Islam, Buddhist, Sunni/Shia, Orthodox

## I. INTRODUCTION

The threat of Global Islam radicalisation to Sri Lanka begins with the advent of the IS propaganda declaring the concept of caliphate and its intentions to redraw the Sykes-Picot 1917 map of the Middle East. Three other major events such as the 1979 Iranian revolution and Ayatollah Khomeini establishing Shia power resulting in the Shia-Sunni deep rooted sectarian violence that is witnessed

today, the war against Iraq in 2003 which deepened the sectarian divide and created a political vacuum that was filled in by extremist groups such as the Jabhat Al Nusra Front, Al Qaeda and subsequently the present day ISIS.

The third is the 2011 Arab spring which begun as a demand for political change but has now turned into a fully blown regional and global proxy war. Subsequent to the Arab spring the world is witnessing an accelerated global influence of Islam radicalisation taking place in



the world due to exploitation of the deep sectarian divide between the Sunni and Shia Muslims and Sri Lanka is no exception to this influence.

Historically Sri Lanka is a multi-ethnic, multi-cultural and multi religious country.

The population of Sri Lanka consists of a 9% Muslim population, which is divided into two different religious sects; 98% Sunni with the Shia and the rest of the sects forming the remaining 2%. Sri Lanka has already experienced the spread of Muslim extremism through the spread of Wahabism and its offshoots, but that has been directed against the fellow Muslims and never against the Sinhalese (Hussain, 2014). This is the divisive line that defines the present day Islam religious conflicts. Taking into account the changing dynamics in the Islam global environment and present day religious contentions between the Muslims, the Buddhist and the sporadic tensions between the Muslims and Tamils, the local Muslim population is susceptible to be made a part of the global Muslim grievance thus creating a sense of solidarity. Therefore, the Sri Lankan Muslim could be exploited by interested parties. For the purpose of this paper Islam radicalisation is defined as follows:

- Radicalisation is defined as a process of adopting an extremist belief system and the willingness to use, support, or facilitate violence as a method of effecting changes in society. Radicalisation can take place within any extremist group (from left/right wing groups to environmentalist, separatist, and terrorist groups). It is important to note that radicalisation as such, does not necessarily have to result in terrorism and the use of violence. (Tomas, 2007)
- Militant Islamist (or violent Islamism) is used as a term for Muslim individuals who use violent means to achieve religious ends which are inspired by the ideology of radical Islam. For example, it is seen as a religious duty to defend Islam against western values and free the occupation of Muslim heartland. For some militant Islamist the goal of establishing a Caliphate is used as a justification for the use of violence. (Tomas, 2007)
- Muslim extremist describes persons who support the ideology behind militant Islam but who do not actually carry out terrorist actions. (Tomas, 2007)
- Islam or Buddhist Radicalisation is defined as a process of adopting an extremist belief system or stance inspired

by the belief of a radical ideology, and the willingness to use, support, or facilitate violence as a method of effecting changes in society in the name of that religion.

### A. Problem Statement

What we are witnessing are the local implications of the influence of a worldwide Islam radicalisation due to sectarian divide between Sunni and Shia Muslims. This situation also influence extreme elements in Sri Lanka to have long term political, social and security implications.

This paper hopes to inspire policy makers to acquire more knowledge and to find suitable effective security and social solutions to deter, prevent and resolve the influence and spread of this phenomenon in Sri Lanka. Therefore, it is prudent to examine if Sri Lanka is ready to face these challenges and seize opportunities to make this country a more secular place for all ethnic and religious communities.

### B. Research Question

Is there a suitable national security and social framework to absorb the effects of growing global sectarian clashes which have inspired Islam and Buddhist radicalisation to pose a threat in Sri Lanka?

### C. Research Objectives

To identify security and social measures that will comply with the constitution, human rights and democracy to tackle the problem of the influence of global Islamic Radicalisation in Sri Lanka.

## II. METHODOLOGY

The research paper methodology is qualitative. The bulk of data is obtained through secondary data. Generation of secondary data for the research is through a review of literature on conflicts believed to be due to Islam radicalisation and best practices to fight this phenomenon.

### D. Scope of the Study

The scope of the study will be restricted to the internal factors of Sri Lanka that will influence in creating a viable mechanism to counter this threat.

### E. Limitations

Imposed limitations by Intelligence Agencies and divulgence of national security sensitive information related to extremist activity in Sri Lanka.

## III.SUNNI SHIA SECTARIANISM

### F. Background

By 632 Islam had consolidated power in Arabia. After the death of Mohammed the debate over succession split the community into Sunni and Shia sects leaving a contest to rule over the caliph.

According to historical facts stated on the Sunni Shia Divide in the web article of Council of Foreign Relations Sunnis dominated the first nine centuries of Islamic rule (excluding Shia Fatimid Dynasty) until the Safavid dynasty which was established in Persia in 1501. The Safavids made Shia Islam the state religion, and over the following two centuries they fought with the Ottomans, the seat of the Sunni caliphate. (Geneive Abdo, 2014). AS a result of this the borders of Iran and Iraq were redrawn in the 17 century by the Sykes-Pigot arrangement as they are today. IN the modern day a majority of the Shia Muslims are habited in Iran, Iraq, Azerbaijan and Bahrain and plurality in Lebanon, while Sunnis make up the majority of more than forty countries from Morocco to Indonesia. (Geneive Abdo, 2014)This historical 1400 years of rivalry is what has manifested into the present day sectarian violence that is seen in the Middle East and has spilled over to the other regions of the world.

1).Population: According to the 2011 Pew Research Centre survey the global Muslim population is to increase from its 2010 estimate global population of 6.9 billion to 8.3 billion in 2030. The Muslim population growth rate is double that of the non-Muslim populations of the world (Brian J. Grim, 2011).

In this context, Sri Lanka has also experienced an upward trend in Muslim population increase. According to the 1981 and 2012 census and statistics the Muslim population in Sri Lanka was 1,121,700 and 1,967,227. This is an increase from 7.56% to 9.71% almost double the percentage increase of the Buddhist population (Izeth, 2014). The reason this has been stated is that the rate of Muslim population growth in Sri Lanka has been subject to debate and concern of the non-Muslim population in Sri Lanka. As, on the face of these statistics it appears that

at this rate of population increase, Sri Lanka is threatened to be a predominantly Muslim country by 2050 causing Islamophobia and other related issues which are perceived as the influence of Islam radicalisation. This perception has been used to stimulate anti-Muslim sentiments among the radical Sinhala Buddhist population in Sri Lanka.

2).The Sunni-Shia Divide: Based on the demographic distribution of Sunni and Shia Muslim populations the sectarian divide between the Sunni and the Shia could be well understood by looking at the ongoing sectarian conflicts in the Middle Eastern and Asian region. The conflicts in Lebanon, Syria Iraq, Iran Saudi Arabia and Bahrain remain sectarian elevated and are countries that have experienced or are having ongoing political or military conflicts mainly based on issues of discrimination due to religious differences fuelled by ideology, groups, associates, religion or family ties to either the Sunni or Shia schools of thought which are dominated by either of the regional rivals Saudi Arabia or Iran. Against this background the fear psychosis of Shia domination or influence in the region was built up by the ISIS in order to attract the Sunni support. In turn Saudi Arabia and Iran and their numerous allies, militarily support the many different groups fighting in Syria or Iraq. The ISIS has also cleverly used its propaganda for three other purposes; to export its terror and also to recruit fighters from the west; to influence vulnerable and willing orthodox Muslims to radicalize and for likeminded militant Islamist in other parts of the world to independently form ISIS support cells. These cells could then be used to carry out organized or lone wolf attacks in countries other than Syria and Iraq.

3).The Sunni-Shia Dividein South Asia: Pakistan is home to 85% Sunni and 15% Shia minority population. Sunni extremists in Pakistan have killed thousands of minority Shias over the past few decades. According to CNN Between 2015 to 2017 ISIS have claimed direct responsibility for 3 deadly attacks that killed 231 and wounded over 560. Bangladesh has a majority Sunni population of 99%. According to IANS web-news article 30 June 2016, Islamists have claimed responsibility for around 40 killings in the last three years (since 2014) of foreigners, secular bloggers, gay activists, Hindus and Christians (IANS, 2016).According to the US State Department country report 2015 terror groups such as AQIS, ISIL have claimed responsibility for attacks against Shias in Bangladesh (Department, Country Reports South and Central Asia, 2015). Maldives is a country with a 99% Sunni population and a state with freedom

of religion restricted. Since 2010, concerns about a small number of local extremist, who support violence are involved with transnational terrorist groups have increased. It is reported that at least 50 Maldivians had opted to become foreign terrorist fighters (Department, Country Reports South and Central Asia, 2015). India has a Muslim population of 14.23% and home to 11% of the world Muslim population (India, 2011). India has raised concerns over the use of social media and internet to recruit, radicalize and foment inter religious tensions in particular the ability of the ISIS to recruit online. The statistics given here show that South Asia has been no exception to the Global influence of Islam radicalisation and producing Militant Islamist inspired by the ideology of radical Islam.

By considering above, it is very clear that the conflicts in the Middle East and South Asia are mainly based on Sunni-Shia divide and projected towards the western nations or its allies' in defiance of western domination and as a symbol of resistance to it.

Therefore, Sunni-Shia rivalry is seen as a regional and international security threat as the rationale behind the threat is to target any form of opposition to the beliefs of the ISIS ideology and this could happen anywhere. What needs to be identified here is the opportunity for Islam militants to carry out attacks targeting symbolic western interests in the country ranging from Embassy compounds, diplomats and tourists etc...etc... Looking at attacks carried out in Brussels, Paris and London in the recent past it is very clear that an, on ground ISIS presence is not needed for these types of attacks to be carried out but could be done by any Muslim group or individual radicalised on line or otherwise.

### III. THE SRI LANKAN PERSPECTIVE

There are two types of Muslims in Sri Lanka. The Moors and the Malays. Both these groups of Muslims are largely concentrated in predominantly Sinhala areas of Colombo, Galle and Matara and in the Central Province hill towns. The rest of the Muslims are concentrated in the Eastern coast Districts of Batticaloa and Ampara.

#### G. Diversification of Islam in Sri Lanka

Out of the 9.7% Muslim population in Sri Lanka 98% are Sunni and 2 % Shia. Out of which 96% are Moors and 2% are Malays. The faith that the Sri Lanka Muslim follows

is South Asian Islam which from its inception has been a benign form of the faith. However, the Muslim population in Sri Lanka over the years has further diversified according to ritual and practice or leadership. Further, the Sunni school of thought has further divided into 6 different branches namely; Sunni Shafii, Sunni Maliki, Sunni Hanafi Barelvis, Sunni HanafiDeobandi, Sunni HannbaliSalafis and Sunni Hanbali Wahabbis. The Shia school of thought has divided into four different branches which are Shia Ismaili, Shia Zaydi, Shia Jafari and Shia Twelver. Further there are six different organisations that the Muslims of Sri Lanka belong to and they are as follows; Thabliq Jaamath, Tharika, Ehewanu Muslims, Thawheed Jaamath, Jamithul e Islam and Jamathul Muslimeen. This diversification has also resulted in varying degrees of radicalization/extremism among these sects. According Schwartz, the Wahhabi, Deobandi, and Mawdudist jihad trends have revealed their ambition to control South Asian Islam through violence in Afghanistan, Pakistan, India, and Bangladesh. In all these countries traditionalists resist them.

The Sufis of Sri Lanka, although obscure to the rest of the world have also taken steps to oppose the spread of radicalization of Islam in Sri Lanka (Stephen Schwartz, 2013).

On the other hand, the phenomenon of global Islam radicalisation effected Sri Lanka in two ways. Firstly, it has affected the Muslim community but not to the extent where rapid radicalisation has taken place where Muslim youth have been stimulated to travel to Syria or Iraq. Nor has it inspired any showcasing of support or violent or radical activity openly in Sri Lanka other than those involved in propagating or supporting extreme ideology online or on the social media. Secondly, it set in motion a wave of Sinhala Buddhist radicalisation through religious and social entities leading to intimidation and violence targeting not only Muslims and Islam but other minority communities/ religions in Sri Lanka.

### IV. DISCUSSION

Even though Sri Lanka has since independence faced periodic inter-ethnic social upheaval, at no given point of time in the history of Sri Lanka has there been inter religious pogroms that altered the social and cultural way of life in Sri Lanka other than for clashes between the fundamentalist and orthodox Muslims. These outbursts of clashes were geographically contained to the local area and

did not take on national proportions. What is significant is that these outbursts of Muslim extremism had no extra-Muslim dimension and were never directed towards other communities.

#### **H. The Influence of Islam Radicalisation in Sri Lanka.**

Sri Lanka unlike many other Muslim countries in the world which has been subject to global, regional and local Islam radicalisation manifesting in varying degrees of terrorism has yet only experienced radicalisation of a few individuals. Even this level of radicalisation has challenged the orthodox Muslim thought and conventions that exist within Sri Lanka without the consensus of the Muslim community. The slow but growing influence of radicalisation, and the subsequent involvement of some of them in terrorist activity is a concern in Sri Lanka.

#### **I. The global, regional and local push/pull factors effecting Sri Lanka.**

The Global influence of Islam radicalisation has influenced Sri Lanka in many ways. To this end, the worldview of Wahhabism and its global resistance to the west or what it terms as western values not falling in line with the sharia, the kinship derived by projecting defiance through Islamic radicalism, the collectiveness shared by radical perspectives and the medium of the internet and social media which plays a key role to indoctrinate vulnerable youth who are born and bred in Sri Lanka and who do not fit into the global trend of 'migrant' are factors of significance. ISIS propaganda is another factor that motivates and drives young believers who are on the margins of Islam radicalism towards militant Islamism. Considering this effect in the South Asian region and on countries nearer to Sri Lanka the functioning of underground ISIS cells in Sri Lanka cannot be ruled out. The fact that 36 Sri Lankans have already joined ISIS and that there are social media platforms in Sri Lanka that support the radical ideology and are gradually increasing in numbers is further evidence to this. (Colombo Page, 2016) Sri Lanka is also vulnerable to regional waves of Islam radicalisation through travelling preachers from countries such as Pakistan, Saudi Arabia and Maldives. Organised and systematic conversion of Shia and non-Muslim poverty stricken families to Wahhabism mainly in the Eastern Province of Sri Lanka is another factor that could have medium and long term effect as part of the increasing Muslim population in Sri Lanka. It is not that there is rapid conversion taking place from village to village and the number today stands insignificant but what is significant is that it is happening.

1). Wahhabism. The spreading of Wahhabism in Sri Lanka took place after 1973. The avenues for the spread of Wahhabism opened with Sri Lankan Muslims traveling to Saudi Arabia for employment. Once in Saudi, these Muslims were given the opportunity through scholarships to pursue further studies of the Saudi way of Islam which is Wahhabism. Those who returned to Sri Lanka after their studies propagated the ideology of Wahhabism by opening madrasas. Further, "to pursue their goal the Wahhabis resorted to violence and intimidation culminating in death and destruction. Our religious society... was not spared and had to face untold hardship." (Stephen Schwartz, 2013). There are numerous instances where Militant Islamist caused sectarian clashes in Muslim populated areas such as Kattankudy (which is the most common geographic area of contention), Beruwela, Aluthgama and Ukuwela and more recently attacks against Muslims by Sinhala mobs also took place in Aluthgama in 2014.

2). The ISIS in Sri Lanka. The unrevealing that a Sri Lankan ISIS fighter Mohammed Sharaz Nilam Mushin aka Abu Shuraih Seylani was killed in Syria on 12 July 2015 (Colombo Telegraph, 2015) and martyred through social media sent shock waves throughout all quarters of Sri Lanka. This confirms the existence of Islamic State-linked jihadist networks in the country and that several other Sri Lankan nationals may also be fighting for the jihadist group in Iraq and Syria. Subsequent investigations revealed that there are a number of 36 Sri Lankans who have travelled from Sri Lanka to Syria and have joined the ISIS. (Colombo Page, 2016). Many Sri Lankans and groups have joined social networking sites which are affiliated with jihadist groups that are linked with the Islamic state in Syria and Iraq. For instance, a Facebook group named "Seylan Muslims in Shaam" (Sri Lankan Muslims in the Levant) urged Sri Lankan people, irrespective of Tamils or native Sinhalese, to join the Jihad bandwagon (Nanjappa, 2016). What is significant is that Nilams postings of ISIS related activity on his face book drew 'likes' from some of his followers in Sri Lanka (Ranga, 2015). This is disturbing as Sri Lanka is a country where a majority of Muslims of Sri Lanka practice an orthodox form of Islam and have integrated well with the Sri Lankan culture and way of life. This incident signals that there are those who condone the acts of violence and ISIS extremist ideology. This has a direct bearing to the threat of Islam radicalisation in Sri Lanka and escalation of rivalry between not only the Sunni and Shia populations but also between the Muslims and other religions in Sri Lanka. This could be considered as an example of the global influence of radicalism to Sri Lanka. According to Professor Rohan Guneratne the ISIS

is spreading like a wildfire in South Asia Governments are only crawling when the ISIS is sprinting (Guneratne, 2016). Even though that is the case in Asia the influence that ISIS has been able to wield in Sri Lanka so far is minimum and no reason for alarm.

According to the All Ceylon Jamiyyathul Ulama, while the government of Sri Lanka investigates the growing stature of the Islamic State, several Muslim clerics' organizations, denounced the ISIS and its ideology. Other than this the Muslim population in Sri Lanka specifically in the East is vulnerable to increasing activity by Whabbi/Salafist activists. One such organization is the National Thawheed Jamaath (NTJ). This is a breakaway group from the Sri Lanka Thawheed Jamaath (SLTJ) who practices a more moderate form of Islam. The NTJ and its leader Saran Moulavi is responsible for spreading of hate speech, printed material and leading activity against other forms of Islam such as Shia, Qadian and Ahmadiyyain the Eastern Province of Sri Lanka. The NTJ is found to promote sectarian friction within Islam such as challenging the orthodox Islam clerics and spreading discord within Islam while preaching a rabid strain of Islam.

Beginning from the early 90's Sri Lanka has experienced a very slow and gradual shift from traditional South East Asian Muslim religious practices which have been deeply integrated and ingrained to Sri Lankan culture towards a more Salafist/Wahabbist teaching. The rise of extremist movements in Sri Lanka has been systematic with the earliest reports coming from the late 90's (Telegraph, 2016). According to Guneratne the ISIS has already several hundred cells in East Bangladesh, Maldives and South India and they have built several organizations in Pakistan and Afghanistan (Guneratne, 2016). Considering this it is very unlikely that Sri Lanka could escape from the influence of Islam radicalization and forming of small cells and groups that support violence.

#### J. The Shia Muslim Factor.

Parallel to other developments it is observed that Shia expansionist have become much more emboldened and active in Sri Lanka since the past decade. It is observed that the Shia segments funded by Iran have now adopted a similar modus operandi which the Saudis' practiced in the early 70's. The Shias are most active in the Eastern city of Valachchenai and its surroundings. Functioning of Shia madrasas, financial aid to poverty stricken families from Muslims, Sinhaleese and Tamil ethnicities, conversion of Sunni Muslims to Shia religion, sending of chosen youth

for further Islamic studies to Iran and other countries that propagate the Shia agenda, functioning of education institutes for higher studies in Sri Lanka, offering of scholarships to chosen individuals are some activity that is carried out to increase the Shia influence in Sri Lanka. This is done in an organized and systematic manner and therefore are considered and perceived by the non-Muslim community as religious expansion and a threat to existing social order.

4).Actors of Radicalisation: The threat to the moderate and orthodox Islam way of life in Sri Lanka, or the actors of radicalisation are the Wahhabi fundamentalist/ extremist/radicalised elements. The actors in this case are politically motivated elements and a few inspired Muslim individuals who come from various walks of life who believe and propagate Islam/Muslim extremism. In addition to this the media and social media also play a role sensationalising and propagating communal or religious disharmony to proportions that they are actually not.

5).The Drivers of Radicalisation. The drivers of radicalisation are; the ISIS concept of the caliphate and its stated boundaries which Sri Lanka is part of, the teachings of salafi /jihadi interpretation of Islam through madrasas, the internet and broad access to social media and sermons contrary to orthodox Islam, ISIS propaganda which are global drivers of Islam radicalisation and finally targeted violence against Muslim population of Sri Lanka by other religions or communities. In the Sri Lankan context socio economic factors such as poverty, unemployment has resulted in religious conversion which in turn is seen as Islam expansion.

6).Polarisation of the Muslim community: The National Thawheed Jamaath (NTJ) and the Sri Lanka Thawheed Jamaath (SLTJ) are two organisations that promote a form of stricter Sharia adherence. These organisations or breakaway groups has the potential to promote militant Islamism in Sri Lanka. The Sri Lanka Thawheed Jamaath also maintains direct links with South Indian Thawheed Jamaath. The NTJ today openly articulates and boldly displays its opposition to those who do not practice Islam according to their beliefs. The NTJ sees themselves as a small group able to take action. However, what is encouraging and important is that at present even though the action is radicalised it is non-violent. Nevertheless, extremist groups such as the NTJ increases the probability of radicalised Muslim

youth embracing militant Islamism. Another important factor often overlooked is the medium of language that the Muslim community in Sri Lanka speak and preach in. The Muslim community has adopted a total foreign language to their original Arabic. The medium of communication adopted is Tamil in all aspects of life, which group them on the basis of language and geography with the Tamil speaking community which has the potential to make an “us vs them” phenomenon when it comes to majority –minority ethnic issues.

7). Growing Radicalisation. The growing anti-Muslim public opinion against certain Islam precepts among the Sinhala Buddhist community in Sri Lanka has been clearly articulated through the many Sinhala radical organisations such as the Bodu Bala Sena and Sinhale organisation. The first of these in the recent past took place with the “Halal Story” in 2013 followed by the visit of a Buddhist extremist clergy Venerable Wirathu from Thailand’s extreme Buddhist party “Ma Ba Tha” in 2014 and then culminating with incidents of violence in Aluthgama in the same year. This and following incidents has resulted in tense majority minority relations. Continuing this manifestation of extreme Sinhala Buddhist political, religious and social opinion as a counter action to global and local radical Islamist precepts and believed expansion, a recent spate of violence against Muslim places of worship and businesses have occurred. The Secretariat for Muslims (SFM) a Muslim civil society organisation documented 548 incidents against the Muslims from 2013 to 2016. (Hilmy, 2017) .In 2017 alone more than 15 incidents of violence of this nature has been documented (Hilmy, 2017). Likewise, during the same period 8 incidents against Buddhist symbols/places of worship specifically from the Eastern Province have been reported. Further, other issues of contention such as Buddhist archaeological land encroachment by Muslims, population expansion are some major concerns that have been given a radicalised connotation.

In this argument it is important to note that not every Buddhist and every Muslim is radicalised and are either militant Buddhist or militant Islamist. But the point to note is that the spate of violence against the Muslim community and also against the Buddhist community continues to take place and any backlash by either of the communities is very likely to bring to the fore front an SIS connotation. As historically the majority population is Sinhala Buddhist and the impulse to perceive Islam as an intruding religion only increases this tendency.

This replicates situations elsewhere in the world, where there are communal and religious fault lines which could trigger greater violence. What is different is, that the situation in Sri Lanka has a Buddhist dimension to it and is not as fluid as the situation in Syria, Iraq, and Turkey or as in Bangladesh. The ground in Sri Lanka however does not provide an opportunity for transnational jihadist movements to spread its influence and recruit more like Mohammed Sharaz Nilam Mushin. Nevertheless, ISIS through social media and propaganda are making inroads to try and shape the environment within the Muslim population in Sri Lanka to be conducive for ISIS passive operations and also to win over the understanding and support for the caliphate. However, the strong integration of the Muslim community to the Sri Lankan culture and way of life has prevented rapid radicalisation and support to the extremist ideology. Having said this, continued targeted violence against the Muslim community by Sinhala extremist groups cannot rule out the Muslim population retaliating violently as a mode of self-defence in Muslim dominated areas. Preparation in forms of self defense classes, rudiment securing/fortifying of villages and arms training are activity<sup>7</sup> to look out for.

Apart from this, in the Eastern and Western areas of Sri Lanka there appears to be a growing complicit secret social surround fuelled by the anti-Muslim rhetoric of extreme Sinhala social cum religious movements that serves to bring together likeminded radicalised Muslim and Buddhist individuals through the internet and other social media platforms. This is a medium that is hard to monitor and preventive action is hard to come by due to lack of expertise, technology, infrastructure, policy and legal framework resulting in the Sri Lankan Law enforcement and security sector being at a disadvantaged position to handle this situation. According to Professor Rohan Guneratne “If ideological extremism is neglected and ignored by any government, it would lead to terrorism in future” and this is a dangerous situation for a country to be in.

Further, the polarisation of the Muslim community is an indicator that the control of the Muslims in Sri Lanka is gradually slipping away from the more moderate orthodox Muslims towards a more radical Wahabbist headship. This could be altered if the more moderate Muslim groups band together to support and alter this wave of radicalisation by getting involved in more active forms of de-radicalisation programmes targeting Muslim communities in areas where there are high levels of Islam sectarian diversity and in low concentrations that under Wahabbist influence.

The moderate Muslim community leaders, religious leaders and educational institutes should get involved in this process at a macro level. A hard check and monitoring and of standardisation of the teachings in Madrasas should be a priority. A coordinated effort must be taken by Department of Emigration and Immigration and other related agencies to curb the influx of foreign preachers.

There is also the Sinhala Buddhist factor that needs to be addressed in this issue. Sinhala extremism in Sri Lanka one can argue creates a necessary counter balance. Nevertheless the government should make initiatives to bring together and engage Muslim, Sinhala and Tamil civil society organisations, religious leaders, intellectuals and community leaders in a bid to settle social differences and hate speech issues. This could also be a platform to address religious conversion.

The current Legal framework to fight ideological radicalisation in Sri Lanka is inadequate. Global best practices should be adopted to suit Sri Lanka in redrafting new laws that will enable Sri Lanka to effectively face the challenge of Global Islam Radicalisation. Stronger international relations and cooperation in the intelligence and security sector to specifically deter and prevent groups such as ISIS making use of Sri Lanka in its greater global expansionist plans could be an effective deterrent to the spread of radicalisation.

## V.CONCLUSION

Sri Lanka is an Island nation and all threats emerging to its national Security come from outside of the country. Then there is also the state vs the individual's belief of what Islam radicalisation is? The state believes that it needs laws and controls to prevent or pre-empt the influence of Islam radicalisation to Sri Lanka and that the individual believer has to give up his right to gain the security of the state.

This social contract between individual and state therefore demands , capacity building in the security sector namely in the Ministry of External Affairs, Department of Emigration and Immigration, Department of Customs, Department of Personnel Registration, Civil Aviation Authority and Intelligence Agencies.

The government should take precedence of adopting a whole of government approach/ Homeland Security concept to deal with issues religious radicalisation, religious militancy, and extremism and other terrorism and related transnational crime.

However, it is not all those who are radicalised that get involved in terrorism or violent activity. Therefore the distinction between violent radicalism and nonviolent radicalism need to be carefully understood and defined when it comes to law making and enforcing. Drafting of a strong legal frame work and adopting a whole of government approach are key factors in countering and pre-empting this global phenomenon from influencing Sri Lankan society and also preventing spill over effects of Buddhist radicalism. However, it is important to comprehend that the problem at its inception could be managed through the existing mechanism that exist within the Muslim way of life and the mosque or Buddhist temple as the binding centre stage. Nevertheless, without state sponsorship and choreographed programmes to achieve a desired government end state the problem could aggravate to limits beyond control. This needs to be guarded against.

If Sri Lanka is to prevent the influence of Global Islam radicalisation and its spill over affects, Sri Lanka should manage this sectarian phenomenon at its evolving stage which is now, where it is still controllable with the cooperation of effected communities.

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# REGIONAL HEGEMONY AND SMALL STATE SURVIVAL: RE – EXAMINING CEYLON’S FOREIGN POLICY UNDER PREMIER D.S SENANAYAKE

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**Abstract** - Literature that deals with Ceylon’s foreign policy during the D.S Senanayake administration (1948-1952) evinces a general hypothesis regarding the close relationship between the Ceylonese administration and the British government. This paper argues that Ceylon adopted an ‘inclination’ to an extra-regional power with the intention of mitigating the threat stemming from India. It argues that Ceylon’s relationship with the British was intended to balance the threat from India. The paper evaluates the threat perceptions from India at the time of Ceylon’s independence and the rationale behind the close relationship between Ceylon and its former colonizer. I have utilized a descriptive, analytical and historical methodology based on existing literature on Ceylon and India to demonstrate the threat perception that Ceylon faced from the latter as well as the underlying reasons behind an ‘inclined’ foreign policy towards the British. The paper examines the security challenges that the small state faced from its incipient regional hegemon and the reasons. Under such circumstances Ceylon chose to be inclined towards the British - thereby balance the threat of India - so as to ensure her survival.

**Keywords** - Ceylon, India, Small State Security, D.S Senanayake

## I. INTRODUCTION

This article explores the foreign policy of Ceylon, under Prime Minister D.S Senanayake, in the wake of the island’s independence from the British in 1948. It surveys the complexities which the island had to face at the time of independence in a rapidly decolonizing world milieu. The paper reviews Ceylon’s modus operandi of ensuring its

survival - eluding a security dilemma with India; through a close relationship with Britain. The paper also strives to rearticulate the traditional definition of foreign policy during this period, which is often dubbed as being ‘pro-western’ in outlook. Independence movements in South Asia differed from state to state and that of Ceylon was structured in an ‘elitist’ fashion. This factor had direct implications on the type of post-colonial government that was established following the provision of dominion status by Britain. At the time of independence Ceylon faced a choice of:

- Implementing a foreign policy that had no leaning towards any country whatsoever and was either
- isolationist in nature or based on building friendly ties with all nations to an equal degree or,
- Establishing a foreign policy that was centred on maintaining a close relationship with the regional hegemon of south Asia – India (bandwagoning with India).
- Or developing ties with an established power which could mitigate the uncertainty the island underwent due to its close proximity to India. Such ties could be of a ‘pro’ tilt or an ‘inclined’ leaning towards an extra regional power.

Although the island chose the last option, this paper argues that Ceylon, decided to refrain from espousing a ‘pro’ attitude towards any country for fear of antagonizing India. I postulate that the rather untested leadership of - Prime Minister D.S Senanayake - devised a foreign policy that was ‘inclined’ towards the British. Nonetheless

the degree of this relationship did not extend beyond an 'inclined' foreign policy which could have antagonized the Indian leadership at that time. The choice of Britain also becomes significant as Ceylon did not engage the animosity of India through an 'inclined' relationship with an extra regional power.

The granting of independence to India in 1947 and the size of India, both in terms of geographic proportions and population had significant implications in chartering a foreign policy for Ceylon. 'Physically India is fifty times the size of Sri Lanka<sup>1</sup> and forty times larger in population' (Kabir, 1996: 9). In order to maintain its survival amidst such a geographical 'giant' Ceylon's prime minister was forced to implement a novel foreign policy in a newly established independent country. Thus, the basic premise of this paper is as follows. While plotting a new foreign policy, although swayed by the close relationship that he and many in his government maintained with the British, D.S. Senanayake did not overlook Ceylon's geographical proximity to India and the latter's regional security concerns.

Based on arguments advanced in Structural realism I argue that Ceylon's proximity to India influenced the foreign policy of the island to be structured in such a way that it did not arouse the displeasure of India. The theory of Neo Realism is employed because it considers structural factors as more likely to explain the foreign policy of states. In this paper I consider the rising threat from India – Ceylon's closest geographic regional power - as the principle structural factor which impinged on the island's foreign policy decision making.

The latent fear of India among Ceylon's leaders created a dichotomy of conflicting views as to how the island should behave in the altering geopolitical environment of the late 1940s - early 50s period. Although diverse opinions voiced by members of the first Ceylonese government remains beyond the scope of this article; it does investigate the factors that the prime minister (also holding the title of foreign minister), had to take into consideration in determining the foreign policy of the island.

In outlining the foreign policy of small states in the anarchic international setting, Rais (1993: 24) notes that 'it would be a wise and natural course for the weaker in any regional system to look towards powers that would support its quest for security'. In Ceylon's context, this was accomplished through:

- a Defense Agreement with the British (1947)
- an External Affairs agreement with the British (1947)
- a Public Officers Agreement (1947)
- maintaining strong trade relations with the British and
- By joining the British commonwealth in the immediate post-independence phase.

All of this points to the endeavours made by Ceylon to maintain relationships with an extra regional power.

At the outset, the paper briefly analyses theories and approaches relevant to the study of foreign policy including the concept of security dilemma. It then observes the process adopted by D.S. Senanayake and his political party in obtaining independence. The paper then draws attention to the country's relations with both India and Britain. Emphasis will also be laid to the terminological difference between a 'pro' foreign policy and an 'inclined' foreign policy to better understand the implications of each and the significance of applying the latter instead of the former. The paper concludes by outlining the significance of an 'inclined' relationship with Britain; both in ensuring Ceylon's independence and in assuaging Ceylon's latent fears of a possible intervention by the emerging regional power – India (amidst the security vacuum created with the British leaving south Asia).

## II. THEORETICAL SURVEY

In analysing the foreign policy of Ceylon during this period of time, the article utilizes the rational actor model and the geo-political model of foreign policy decision making. It takes into consideration both, idiosyncratic variables of the decision maker – D.S. Senanayake - as well as the structural variables pertaining to the 'geographic realities and ideological challenges from potential aggressors' as outlined by James Rosenau (1975: 39) in his pre-theory of foreign policy. The use of idiosyncratic variables (under the rational decision making model) in juxtaposition with the geo political model (which focuses on the structural variables of the international milieu) ensures that limitations present in each individual model are averted through the use of an eclectic approach. However the influence of structural factors such as India's proximity to the island had pre-eminence over idiosyncratic variables. Thus the proximity of India predisposed D.S. Senanayake to move towards an extra regional power but his

comprehension of India's security concerns resulted in an 'inclined' relationship over a 'pro' relationship with U.K.

The paper also argues that in the 'process of elaborating appropriate courses of action, actors inevitably have to take into account the strategies of all other players' (Brighi and Hill, 2016: 149) and Ceylon in particular, had to grapple with all the possible courses of action that India might take towards the island following India's independence in 1947. Finally the paper makes reference to the balance of threat theory. As its name implies, this theory predicts that states will balance against threats. This theory is based on the notion that 'if one state becomes especially powerful, and its location and behavior feed threat perceptions on the part of other states, then balancing strategies will come to dominate their foreign policies' (Wohlforth, 2016: 40-41). In this context - apprehensive of the rise of India as a regional hegemon - Senanayake decided to build an 'inclined' relationship with an extra regional power; balancing fears of India through ties with U.K.

### **A. Security Dilemma in the Context of India and Ceylon**

Security dilemma was identifiably the most probable outcome between Ceylon and India following Ceylon's inclination with Great Britain. But why was it important to ensure that a Security Dilemma did not emerge when Ceylon developed ties with an extra regional power? And more importantly what are the ramifications of creating a Security Dilemma between India and Ceylon? In order to better understand the context of Ceylon at the time of independence, a brief examination of what a Security Dilemma is and what it entails needs to be discussed. Security Dilemma, an often deliberated concept in the realist school of thought deals with a situation 'whereby nations taking steps to enhance their own security infringe upon the security concerns of their adversaries, thus triggering a spiral of distrust' (Leffler, 1994: 16; also see: Waltz, 1979:186; Wheeler and Booth, 1992: 30).

'At the heart of the security dilemma are two constraints: the inherent difficulty in distinguishing between offensive and defensive postures and the inability of one state to bank on the fact that another states' present pacific intentions will remain so' (Art and Jervis, 1996: 3). 'Since no state can know that the power accumulation of others is defensively motivated only, each must assume that it might be intended for attack' (Snyder, 1984: 461; also see: Glaser, 1997: 171; Mitzen, 2006: 354). Therefore 'even if they can be certain that the current intentions of other

states are benign, they can (not) neglect the possibility that the others will become aggressive in the future' (Jervis, 1976: 76).

Security dilemma is by no means uncommon to the south Asian region and small states generally struggle to ensure their survival in the context of a larger geographical neighbour (Cooray, 1992: 313). Although security dilemma generally leads to a self-defeating cycle whereby the original intention of a state to fortify its power leads to a reactive strengthening by the other, not doing so at the time of independence risks the state falling under the clutches of a regional power (Tang, 2009). Traditionally, the threat perception from India among smaller states and the fear of Indian hegemonic behaviour in the post-colonial phase have dominated the bilateral relations between the smaller neighbouring states and India. While some states bordering India decided to create a close relationship with it, others such as Pakistan, distanced themselves from New Delhi and attempted to formally align with states outside the region. Pakistan's alignment first with countries of the Arabian Peninsula and later with the west, was perceived by India as an attempt to 'attain parity with India and to challenge the natural power hierarchy of the subcontinent' (Cheema, 1992: 55).

Ceylon also followed the latter course to a certain degree and developed a close relationship with Britain primarily through a defense agreement and external affairs agreement in 1947. However in contrast to Pakistan, Ceylon was also able to maintain an amicable relationship with India although her prime focus was on deepening ties with the United Kingdom. Finally, in my examination of Ceylon, stress is laid on the concept of 'power vacuum' which is perceptible in south Asia following Britain's withdrawal from the region.

The British withdrawal is reflected by the granting of independence to many of its former colonies. As outlined by Denny Roy, a power vacuum or security vacuum 'applies to the following scenario: as the influence of the dominant country is seen to recede in a given region, at least one of the other regional states, previously restrained by the erstwhile hegemon, attempts to expand its power. This expansion is rapid and purposeful, based on the perception of a window of opportunity, rather than gradual or evolutionary' (Roy, 1995: 46). How was this concept manifest in South Asia? India's geographic size, military and economic strength in comparison to her neighbours were identifiably greater and patently the British withdrawal from south Asia resulted in the resurgence of India as a powerful regional hegemon.

## B. The Process of Obtaining Independence

Ceylon obtained her independence from Britain in 1948, a year after India and Pakistan. Her independence 'struggle' was a non-violent one, beginning and ending primarily through constitutional reforms and formal requests made to the British government. In the context of obtaining independence in 1948, the island has much to owe to the combined efforts of the 'triumvirate' – D.S Senanayake, Sir Oliver Goonetilleke and Sir Ivor Jennings. Subsequent to her independence, the island faced countless difficulties, both internally and externally. In terms of conceptualizing the island's foreign policy during this time; considerable weight falls upon the Prime Minister and the political party which he belonged to, on ascending to power. The United National Party (UNP) tended to maintain strong links with their colonial masters and more often than not, had a noticeable leaning towards the capitalist camp in general and towards the United Kingdom in particular.

'The UNP leadership looked upon the country's defense policy largely from the point of view of Indian dominance in the country's immediate defense and strategic environment....This combined with a) the close community of interests they found with the west and b) the then emerging cold war conflict led to a general strategic alignment between Ceylon and the west during the first decade of independence.'(Gajameragedara, 2011: 50)

Sri Lankan historians and academics habitually categorize the foreign policy, followed under the UNP at the time of independence, as being 'pro-west'. They also attribute this term to the first three prime ministers of Ceylon although a closer examination of the context of each prime ministers' term is generally not taken into substantial consideration.

'This view was based mainly on the interpretations given first, to the Defense and External Affairs Agreements; second, to the membership of the Commonwealth; third, to the rhetoric of foreign policy' (Karunadasa, 1992: 71).

In seeking to clarify the reasons behind D. S Senanayake's decision to veer towards Great Britain I concentrate on the threat perception; specifically in terms of territorial security, which emanated from India at the time of Ceylon's independence. However before such an examination could take place an analysis of the difference between a 'pro' and inclined foreign policy is in order.

## C. An 'Inclined' Versus 'Pro' Foreign Policy

Throughout this paper 'inclined' refers to a decision to maintain close relations with a country due to externally based threat perceptions; while a 'pro' policy towards a state would exclusively necessitate a personal disposition of the leader towards that particular state. A 'pro' foreign policy would have influenced Ceylon to align with a stronger or weaker power and formulate linkages of an economic, security and political nature solely due to Senanayake's personal whims. Thus, in the case of a 'pro' relationship, idiosyncratic variables triumphs over systemic variables and in the case of an 'inclined' relationship systemic variable surpass idiosyncratic variables. This however does not mean that systemic variables determined Ceylon's foreign policy under Senanayake in entirety. On the contrary while systemic variables was the biggest push factor for a relationship with an extra regional power; the hue of 'inclined' over 'pro' was adopted due to Senanayake's consideration of India's security concerns following an extra regional powers involvement in south Asia.

The rhetorical trope of identifying Ceylon's foreign policy as 'pro-British' may lead to a myopic understanding of the islands foreign policy under its first Prime Minister. Such rubric has important implications in an appreciation of small states' security considerations in the backdrop of a potent regional power. The sections below reason that at the time of independence, Ceylon faced significant threat perceptions from India, primarily of a military/security nature. This aspect led Ceylon to chart a foreign policy that was decidedly set on building ties with an extra regional power to offset its fears of India. In doing so Ceylon turned towards Britain as its choice.

## D. Ceylon: The Complexity Of Chartering A Foreign Policy

Ceylon's strategic position in the Indian Ocean and the relative ease of managing the island in comparison to the larger geopolitical entity of India; made it difficult to convince the British to grant independence following the end of the Second World War. Constant negotiations and deliberations between Ceylon and Britain eventually led to the attainment of dominion status on February 4th 1948. The manner by which Ceylon secured independence was especially significant as:

'It was for the first time in the history of decolonization that a non-white colony was granted independence through negotiations between the national political

leader of a British colony and the imperial British government.’(Karunadasa, 1997: 12)

Agreements including the defense and external affairs agreement were signed by Ceylon on November 11th 1947. They subsequently came into effect following independence on February 4th 1948. Although termed as a ‘sine qua non’ (Kodikara, 2008: 30) by some academics and as an ‘integral part of the independence package’ (Keerawella and Siriwardena, 1992: 236-37) by others, Ceylon’s defense agreement with the United Kingdom brought significant benefits to the island in the context of an emerging India. This was because, in the milieu of a stronger geo-political neighbour, Ceylon was compelled to acquire an insurance of its security through a closer relationship with a much stronger extra regional power.

Ceylon possesses a land area of 65,610 square kilometers, a territorial sea of 12 nautical miles and a contiguous zone of 24 nautical miles. (The World Fact book –CIA) Its close presence to the southern tip of India has - in the past - led to many foreign interventions (both peaceful and violent) since the establishment of an autonomous civilization (De Silva, 2008: 18-141). Many of these foreign interventions were conducted by various Indian regional rulers in ancient times and the impact of this is still latent in the psyches of certain sections of its citizens. Urmila Phadnis confirms this by claiming that ‘The geographical contiguity of a small country with a big one, through which it had often been conquered in the past, prompted the Ceylonese leaders to attempt to balance their dependence political, military or economic-by developing cordial relations with another power as large and powerful as India’ (1963: 189).

With a security vacuum emerging, following the gradual removal of Britain from south Asia, Ceylon anticipated the incipient rise of India as the regions’ hegemon. As a small state closely located beside an inchoate regional hegemon, Ceylon had to negotiate the rise of India and maintain a favourable relationship with it, without which its independent status would be at risk. Thus Ceylon had to factor both the gradual removal of Britain from the region and the rise of India in the heated climate of the cold war. These concerns were compounded by apprehensions relating to the political, economic and social condition of the country.

‘In fact at the time of independence Sri Lanka had many problems not shared by other commonwealth partners. Most prominent among these were the lack of armed forces for self-defence, lack of machinery for conducting external relations, non-membership in the United Nations,

local communist activities and problems of economic development’ (Karunadasa, 1997: 25-26).

Literature dealing with India’s rise to power and its relationship with Ceylon has a tendency to discount the image of India as non-threatening and as less influential than it assumes to be. Sankaran Krishna (2000: 28) discloses that ‘Although Indian self-fashioning had always aspired to the legacy of the British as sub continental gendarme, it remained largely rhetorical until 1971’.

Nevertheless as the following section explains, Ceylon perceived a military threat from India largely due to India’s actions and the scholarship of Indian writers at the time. Unable to effectively deal with the mounting tensions among the Sinhalese community, particularly in the central upcountry (due to the presence of Indian migrant laborers) D.S Senanayake had to correspondingly contemplate the threat to the national security of the island. It was here that the needs of both the British ‘Whitehall’ and UNP met. ‘Profound suspicion of India (which became) the dominant strand in his external policy’, (De Silva, 2008: 623) led Senanayake to seek reassurance through an alignment with Britain.

### **E. Threat Perception from India**

This section argues that the D.S Senanayake administration, during the latter 1940s and early 50s, was wary of India and inculcated a sense of anxiety towards her large geopolitical neighbour. Eminent writers of Indian foreign policy such as K.M Panikkar declared that a ‘realistic defense policy’ of India needs to take into consideration the prerequisite of consolidating maritime supremacy. Such a foreign policy appears to have been inherited by the early British administration of India. Panikkar (1960: 23) goes on to say that:

‘An integrated conception of the defense of India and a doctrine of Indian defense supported by a consistent foreign policy are among the two major contributions of Britain to the Indian People’.

Ceylon harboured fears of Indian expansionism because such a military policy, if executed, could threaten the national security of the island (Kodikara, 1993: 10 – 15; Kodikara, 1965: 24). Panikkar identified himself with the ‘British lake view of Indian security and proposed a defense system which would be based on the same logistical principle’ (Mendis, 1983: 389). Such a policy would entail New Delhi’s dominance in the Indian Ocean as well as

complete control over all maritime activities. In 'India and the Indian Ocean', Panikkar propounded the idea of 'strategic unity' between India, Sri Lanka and Myanmar, as one of the pre-requisites to a 'realistic policy' of Indian defense and even observed the strategic significance of the Trincomalee harbor in relation to India's conceptualization of maritime defense (Panikkar, 1951; also see Balkrishna, 1949). Wiggins (1965: 377) also pointed out the possibility of Indian occupation of key strategic locations in Ceylon; testifying that: 'If Indian security was threatened from the Indian Ocean or in a combined attack from the Nepal area and the sea, Indian occupation of Trincomalee would be likely'.

Ramachandra Rao (1954) only added to these apprehensions by asserting that Ceylon lies within the Indian defense perimeter. Vaidya (1949: 30) avers India's right to dictate terms to small states in the region, insisting that 'the first and primary consideration is that both Burma and Ceylon must form with India a basic federation for mutual defense whether they like it or not.' Contentions by Panikkar (1951: 84) such as: 'The Indian Ocean must therefore remain truly Indian,' may have served only to kindle fears among the Ceylonese leadership as to what the true intentions of India may be.

Statements by the soon-to-be Indian leader, Jawaharlal Nehru before independence, did not assuage this mounting tension. In 1944 Jawaharlal Nehru stated that: 'The small state is doomed. It may survive as a cultural autonomous area but not as an independent political unit.' In the following year he added that Sri Lanka would be inevitably drawn into a closer union with India 'presumably as an autonomous unit of the Indian federation' (Kodikara, 1992: 25).

However after independence, Nehru desisted from rhetoric that would augment the ambience of fear and uncertainty; and instead attempted to ease the tension surrounding India's intentions, especially vis-à-vis Ceylon (Nehru, 1950). The rhetoric by the Indian premier belied actions. India's act of taking over princely states such as Hyderabad (1948), which wished to remain independent, only exhibited the behavior of an aggressive regional power (see: Hilali, 2001: 36; Maxwell, 1974: 637-638; Thomson, 2013). Moreover, New Delhi's decision to militarily threaten Pakistan by amassing troops on the Indian border in 1950 and 1951 also served to increase the unease among its neighbouring small states (Werake, 1992: 264). Naturally such actions may have influenced any leadership to subscribe to the notion that the actual

intentions of India appeared to be threatening, despite the rhetoric by the Nehru government suggesting otherwise. Thus applying the 'strategic-relational approach' in this context demonstrates how D.S Senanayake would have to factor such changes in the regional environment of Ceylon; ensuring that relations with India was kept under amicable terms. However the actions of India in both cases mentioned above, would attest to the contestation that India was assuming to be the regional hegemon of south India and that a balance of threat theory would necessarily have to be applied by Ceylon.

'On the one hand, the inherent fear combined with the vulnerability of their island country, necessitated the Ceylonese leadership to have a friendly policy towards India. On the other hand, because of their fear and perception of the vulnerability of their island country, they were not prepared to press this friendliness to the extent of forging a close political link with India' (Gajameragedara, 2011: 133).

The British effectively utilized this uncertainty in the relationship between the two countries to obtain a military presence in the coveted Indian Ocean. The British administration, instead of lessening such fears as undue suspicions, sought to heighten the existing unease. They conveyed plausible threats which Ceylon may face from India in their official texts. In a 1947 report by the chief of staff committee of the British government, such fears were expressed in the following manner:

'A threat to the territorial integrity of Ceylon is likely to come only from India.....The danger of India (particularly congress India) interfering with Ceylonese internal politics.....is a real one' (Bhasin, 2001: Xviii - xix).

Another latent yet duly discerned portent was the possibility of south India separating from the Indian government and establishing a separate country (Jeyaraj, 2009). Assuming that south India was to separate, the possibility of it amalgamating the north and east of the island was conceivable due to the ethnic linkage that exists between the south Indian and Tamil population in the north of Ceylon. Not only would such a separation of India create a new geopolitical entity that Ceylon would be forced to interact with, but the likelihood of it incorporating parts of the island which had an ethnic affinity with southern India meant that the country faced a tremendous national security threat. According to the strategic-relational approach, this would complicate the structure of south Asia by adding another state in-between

India and Ceylon creating a loss of land from both states. Thus, survival as an independent island would be at risk if such a geopolitical alteration was to take place.

Distinctions and divergence between India and Ceylon became even stronger after independence. While India forged ahead to create an autochthons constitution (Shivprasad, 2013), Ceylon continued to maintain its Soulbury constitution until 1972. This constitutional development in India in contrast to Ceylon's tenacity with the Soulbury constitution strengthened the growing divergence between the two countries. The strong antipathy towards certain British colonial policies among Indians in comparison to the lack of such feeling towards the British among Ceylon's 'elitist' leaders only assisted to create a divergent attitude among the two governments. Unlike India, whose leaders had been forced to follow a tortuous path to independence, 'Sri Lanka had negotiated its freedom from Britain in a largely amicable way and to Senanayake as to the other leading members of the new government; Britain was a safe and trustworthy ally' (Samaraweera, 1997: 338).

Advising the Nehru government of the attitude of small peripheral states such as Ceylon another Indian writer suggests: 'the first and foremost task before New Delhi is to direct its energies to dissipating the prevailing distrust and suspicions of India among the smaller neighbors, particularly Nepal, Ceylon, and even Bangladesh, who are all mortally afraid of a possible Indian domination over them' (Mankekar, 1974: 21).

Eminent personalities such as Sir Ivor Jennings considered India a 'friendly but potentially dangerous neighbor' (1951: 113). As the most immediate 'neighbor' to the island; the possibility of India incorporating Ceylon under its defensive command if it desired to follow the British maritime policy was feasible to Sir Jennings. Under such circumstances the D.S Senanayake administration, in order to ensure the territorial integrity and political autonomy of the island, may have been decidedly prone to sign a defense agreement with a strong naval power. 'He held the view that the best guarantee of Ceylon's independence was the goodwill of the power which had granted it. He therefore concluded agreements with the United Kingdom' (Hulugalle, 1975: 201).

Owing to the fact that Ceylon did not possess a strong tri-force; the defense agreement with the British became a 'safety net' (Devendra, 2015: 185) to ensure Sri Lanka's survival against a potentially aggressive India.

'The country's survival in the post-independence situation was foremost in Prime Minister D. S. Senanayake's thinking. His survival agenda was shaped by the belief that India was the most likely threat to Sri Lanka's independence' (De Silva, 1995: 17). Having established the threat perception from India to Ceylon, the paper consequently analyzes the reasons why Ceylon was impelled to choose Britain to aid in protecting her, instead of any other 'Great' power.

#### F. The Choice Of Great Britain

Ceylon cemented her post-independence ties with Great Britain through agreements which came into effect on 4th February 1948. Under the impression that Ceylonese independence could only be 'safeguarded' (Nissanka, 1984: 11) through a closer connection with the United Kingdom, such agreements were concluded a year before independence. Although carrying significant benefits to the British; the defense agreement and the Commonwealth membership agreement became the mainstay of Ceylon's survival strategy.

Some scholars of foreign policy argue that the actions of Ceylon during this period of time reveal a 'pro' west, 'pro' British foreign policy. They contend that the UNP, because of its 'pro-Western and comprador character entered into a defence arrangement with the British in 1947' (Lenka and Pattanaik, 1979: 54). Such propositions draw attention to the external affairs agreement and the defense agreement with the British as reason to suggest that the foreign policy of D. S Senanayake was 'pro' west. This paper argues that the agreements were signed due to the threat perceptions that Ceylon faced from India at the inception of independence. The section above clearly elucidated the actions undertaken and statements echoed in India which reflected it in the light of a regional hegemon.

This section argues that such threats were grounds to initiate an 'inclined' foreign policy with the British. It also inspects the motives as to why the Prime Minister chose to strengthen Ceylon's ties with the British instead of any other regional or extra regional power(s). During the late 1940s many of the regional powers of the Indian subcontinent were emerging from the shackles of colonization. Colonization had taken a significant toll on the domestic economies of the states, which were contingent on producing primary agricultural products. Such production activities required low skilled employees and more often than not; a large portion of the domestic economy rested on the revenue of such products. Ceylon was no different to this economic model as its economy was closely tied to the British market.

'In the economic sphere, Sri Lanka was dependent for tea export on London. Most of the tea of Sri Lanka was sold through the London tea auction. This linkage with London also had its influence on Sri Lanka's relationship with Britain' (Patnaik, 2014: 59).

This close linkage with the British market and other western markets in Europe and America helped solidify ties with the west. If India post-independence, sought to attain the naval prowess of the British, it would seek to extend its authority throughout the Indian Ocean. Under such circumstances - assuming that Ceylon exhibited a foreign policy that was not in favor of India - the possibility of the latter preventing maritime trade and implementing a blockade crippling the Ceylonese economy was worryingly conceivable.

Nayani Melegoda acknowledges Ceylon's level of dependency with regard to foreign trade in the following manner:

'D.S Senanayake knew from experience during the Second World War how necessary it was to keep Ceylon's sea and air bases free from obstruction in order to bring in the essential imports like food stuffs, without which the people would starve. Nearly one half of all food consumed was imported, one half of Ceylon's rice was from abroad, 99% of curry stuff, pulse, and dried fish important for curries and 100% of wheat and sugar were also purchased abroad' (2000: 79).

In this context, the defense agreement can be regarded as an organic extension of the existing trade relationship between Ceylon and the United Kingdom. Additionally the choice of Britain gets further impetus when one takes into account the fact that Britain was the dominant naval power in the Indian Ocean during this period of time. John Kent's chapter on the British policy following the end of World War 2, in the comprehensive study 'Origins of the Cold War', admits that Britain was still dominating the maritime region in the Indian Ocean even at the beginning of the Cold War (1994: 155-65). The choice of Britain naturally appealed to Ceylon as it would become an effective deterrent to any possible military action that India could take against Ceylon, post-independence. Thus the overwhelming naval superiority of Britain could channel Indian hopes of expansionism away from Ceylon by underscoring the possibility of Britain coming to the aid of the island. Since Britain was conceding territory by granting independence to its former colonies, the British appeared to be far removed from expansionist

tendencies that had characterized their colonial exploits in the preceding century. Moreover with the bi-polar Cold War taking shape in the late 1940s, Senanayake assumed that a relationship with Great Britain would be an indication personifying Ceylon's willingness to side with the democratic camp despite professing to be on the 'middle path'. As Ceylon 'ideologically identified itself with the west' (Jayawardane, 2004: Xxxii), maintaining an inclined policy with Britain appears to be a natural progression of the Ceylonese government. However, this does not warrant a classification of Ceylon's foreign policy as 'pro' west. Ceylon chose to incline towards Britain and the western camp due to genuine threat perceptions from many sources, principally stemming from India.

Any state aligning itself alongside the capitalist camp by siding with the United States of America would certify the antipathy of the Soviet Union to be directed towards it. Although the following case could be considered a conjecture, if the Soviet Union became closely allied with India (as it later did in the 1970s), the Soviet Union may perhaps support an action by India to invade the island, if such an opportunity to descend upon Ceylon emerged. This would adversely harm the island and therefore being inclined with the British seemed to be the best way forward. Even prior to independence Ceylon's leaders had a strong working relationship with British parliamentarians and knew much of the designs of Whitehall.<sup>2</sup> Having a strong rapport with Britain enabled Ceylonese politicians at that time, to believe that differences and disagreements between Ceylon and Britain could be ironed out through discussions and negotiations. This also showed Britain in a favourable light to Ceylonese leaders and henceforward Britain became the go-to-choice of Ceylon in ensuring its security.

Additionally, Ceylon believed that among the states that it could turn-to for defense; Britain was among the first of a very few. D.S Senanayake voiced this sentiment when he commented: 'Around countries of the world, I see at this moment, only one country with sufficient interest to defend us at their own expense, and that country is Britain' (Hazard, 1947: 445).

The prospect of India allowing Ceylon to ally herself with a country that may auger alarm among Indians was inconceivable. The then Congress President Dr. Pattabhi Sitaramaya declared in 1949 that: 'India and Sri Lanka must have a common defence strength and common defence resources. It cannot be that Ceylon is in friendship with a group with which India is not in friendship...and in light



of this, one can determine that 'This led India to accept Sri Lanka's defence arrangement with Britain as India did not have any conflicts with London' (Patnaik, 2014: 63). As Ceylon's increase of power (through her relationship with Britain) did not stir fear in India, it would ensure that her power as a state increases while at the same time; not generating a security dilemma among Indian political circles. This demonstrates a foreign policy analogous to teachings of Defensive Neo Realism.

Gamini Keerawella alludes to another likely reason why Ceylon's inclination towards Britain benefited the island. Until the early 1960s considerable amount of weapons and armaments required by India was imported from Britain. Not only does this suggest that India did not have any unease regarding the United Kingdom but also that India was ready to request the assistance of Britain to supply it with the necessary resources for its own defense. (Keerwella, 1992: 428). Likewise, Appadurai confirmed the trust and healthy relationship that existed between the two countries in the post-independence phase by disclosing that 'India (is) now dependent on Britain for the bulk of her essential military stores' (1949).

Thus the consolidation of ties between Ceylon and Britain - leading to an inclined policy towards the latter - became the central feature of Ceylon's foreign policy in the 1940s and 50s. Not only did Ceylon ensure her security by affiliating herself with the strongest naval power in the Indian Ocean region through a defense agreement, but she also ensured that the inclination towards an extra regional power did not produce a security dilemma between India and Ceylon.

Joining the Commonwealth became propitious to Ceylon in 1948, as the island obtained international recognition as a sovereign state; in the backdrop of a soviet veto that denied it the same in the United Nations. Ceylon also represented the region of south Asia within the Commonwealth; alongside Pakistan and India, allowing for increased opportunities to interact with state leaders. Ceylon's membership in the Commonwealth also conferred the tacit acceptance of parity (by India and Pakistan) as a sovereign entity.

Senanayake's desire to join the Commonwealth corroborates the assumption that Ceylon chartered a foreign policy that was closely inclined towards the British. Evincing D.S Senanayake's desire, Wiswa Warnapala observes that the Prime Minister: 'Was obsessed with the belief that the membership of the Commonwealth would help the island to preserve its newly

won freedom. The safeguarding of the islands security was the most important consideration and the fear was that Sri Lanka would be left defenseless after the departure of the British forces' (1992: 149). Thus Ceylon's decision to become inclined with Britain appears to have been a natural production of the islands concern over India and its intentions. Through this 'inclination' Ceylon navigated the unfamiliar waters of the international system in a bipolar world - all the while - ensuring that the national security of the island was preserved through ties with the British government. While all possible avenues of strengthening ties with the United Kingdom were pursued by Senanayake, India was not forgotten in the process. In fact Ceylon welcomed the Indian Prime Minister in 1950 and discussions became frequent between the parties as the years went on. However this relationship was an 'arm's length' relationship focused on neither irritating nor overly trusting her larger geographic neighbour.

#### IV. CONCLUSION

This paper outlined the Indian military threat which the small state of Ceylon had to factor, when forming the islands foreign policy. It ascertained that the threat to the security of Ceylon principally emerged from India and the need to manage such apprehensions, led the island to incline itself with an extra regional power. The paper also argued that Ceylon's choice of the extra-regional power was a sentient effort to refrain from irritating the rising power of India. For this purpose Ceylon chose Britain. However Ceylon's foreign policy was not a 'pro- British' foreign policy but an 'inclined' foreign policy. Ceylon's preference was Britain since a relationship with Britain was seen to be, among other reasons, non-threatening to India while at the same time, significantly increasing Ceylon's defense capabilities. As a result Ceylon was able to balance the threat from India by 'inclining' towards a state that India was not apprehensive of. Thus Ceylon was able to ensure her survival as a newly independent sovereign country at the inception of independence through an inclined foreign policy with the British and an 'arms-length' foreign policy towards India.

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# HOT PURSUIT ON LAND: EXECUTION VERSUS LEGITIMACY

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## I. INTRODUCTION

There is a clearer authority when it comes to pursuit on the sea. The 1958 Geneva Convention codified authorities' right to pursue and apprehend ships that have violated a nation's laws and have escaped from a country's national waters into international waters.

This principle is enshrined in Article 111 of the 1982 UN Convention on the Law of the Sea and in Article 23 of the 1958 Convention on the High Seas. In simple form, the doctrine generally pertains the ability of one state's navy to pursue a foreign ship that has violated laws and regulations in its territorial waters (twelve nautical miles from shore), even if the ship flees to the high seas.

## II. HOT PURSUIT ON LAND

Hot pursuit on land can be describes as the right to pursue and apprehend an opposing force on another state's land. International law experts say that there is a recognized right of hot pursuit to pursue ships escaping in international waters but there is no similar global legal authority that would allow one nation to violate another nation's border to pursue an opposing force on land. Thus, in enforcement it is evident in many cases that several leading states use hot pursuit on land in their military actions, especially by U.S. forces.

Moreover, it can be introduced as a trend that principle of hot pursuit on land is being enforced by many states wrapped as a 'right' by giving out several reasons such as self-defence. Thus, according to legal perspective, right to hot pursuit on land contributes in violation of state sovereignty and territorial integrity. On the other hand, yet it is debatable whether hot pursuit on land can be considered as a principle or not.

## III. METHODOLOGY

In order to find possible answers to afore discussed points, the research design of this paper is based on qualitative legal research methodology focussed on primary sources of applicable legal rules and case laws and secondary sources of media and internet in order to resolve the research problem to evaluate the legality of the principle of hot pursuit on land versus it's execution. Therefore, this paper is designed first to evaluate the execution of principle of hot pursuit on land from ancient history to

modern context and secondly to critically evaluate the legality of the principle. Ultimately, it is to evaluate the status of legality of the principle versus its enforcement.

## IV. EXECUTION

Hot pursuit on land is not a modern phenomenon. History is replete with examples of foreign agents or armies crossing another state's sovereign borders in pursuit of those suspected of committing crimes against another state. The legend of Rawana can be considered as the prime ancient example, due to the fact that Rama has pursued the opposing force of Rawana in Rawana's Lankapura.

## V. HOT PURSUIT ON LAND UNDER INTERNATIONAL LAW

Legal experts agree that the principle of 'hot pursuit' as it pertains to sovereign territories versus the high seas, remains unsettled. Temple University law professor and international law authority Peter J. Spiro said the hot-pursuit doctrine is well-established in criminal law. (Braun 2014) Hot pursuit on seas possesses a legal recognition

whereas the legal credibility of hot pursuit on land is still debatable. However, there seems a trend of which veiling hot pursuit on land under the right of self-defence by states.

Article 51 of UN Charter deals with right to Self-defence of States. Accordingly, “Nothing in the present Charter shall impair the inherent right of individual or collective self-defence if an armed attack occurs against a Member of the United Nations, until the Security Council has taken measures necessary to maintain international peace and security. Measures taken by Members in the exercise of this right of self-defence shall be immediately reported to the Security Council and shall not in any way affect the authority and responsibility of the Security Council under the present Charter to take at any time such action as it deems necessary in order to maintain or restore international peace and security”

However, as per Braun (2014) United Nations Security Council has once authorized sea-to-land pursuit in Somalia.

## VI. HOT PURSUIT ON LAND BY U.S. FORCES

As the scope of this research is limited to study the principle of hot pursuit on land by U.S forces it seems essential to discuss on the historic incidents. One famous example is the pursuit of Pancho Villa by U.S. forces into Mexico in 1916. Another example was the 1960 seizure of Adolf Eichmann by Israeli agents in Argentina. Eichmann was a former high-ranking Nazi official wanted for war crimes.

His capture was widely considered a violation of international law and Argentine sovereignty. Neither of the above cases involved ships on the high seas, nor did either of the states invoke the principle of ‘hot pursuit’ to justify their cross-border activities. Even without that precedent, numerous nations have repeatedly taken action across borders, including raids by U.S. troops in recent years pursuing militants from Afghanistan into Pakistan. (Braun 2014)

### A. Right to Hot Pursuit and Right to Self-Defence

This idea of ‘hot pursuit’ is just an attempt to twist the law of the sea doctrine into a self-defence idea. International law authorizes military action if a nation can show it is acting in self-defence. But even recognizing that nations

have repeatedly invoked their self-interest in striking opposing forces across borders, legal experts said there is no governing international legal code that recognizes a reflexive right of hot pursuit on land.

As per the words of US Secretary of State John Kerry, “‘hot pursuit’ is a little grounding principle in international law as a basis for attacks on the militants. And as a matter of right, if they’re being attacked from outside their country, you have a right of hot pursuit. You have a right to be able to attack those people who are attacking you as a matter of self-defence” As a Swift Boat commander during the Vietnam War, Kerry practiced a version of hot pursuit on his own, beaching his boat to pursue Vietcong guerrillas firing from land. (Braun 2014)

Under International legal norms on state responsibility, and UN Security Council Resolution 1373, passed shortly after the events of 9/11, state responsibility implies a duty to control one’s territory.

That is, a government has an obligation not to allow its territory to be used by non-state actors or terrorist organizations to carry out armed attacks against its neighbours. In the case of Syria, the U.S. government could invoke UN Security Council Resolution 1373, which says that states have the responsibility to prevent the misuse of their territory by non-state actors like al-Qaeda. Syria must prevent its territory from being used as a safe haven for terrorists and patrol its border to prevent attackers from entering Iraq. Under UN Security Resolution 1373, states are obligated to “deny safe haven to those who finance, plan, support, or commit terrorist acts, or provide safe havens” and “prevent those who finance, plan, facilitate or commit terrorist acts from using their respective territories for those purposes against other states or their citizens.”

Failure to comply could prompt UN sanctions against Syria. But Damascus is not directly responsible for the actions of these foreign jihadis unless it can be proven to exercise “effective control” over them, a high threshold to meet under international law. As per U.S. official estimate, most of the foreign-born insurgents in Iraq enter the country through the Syrian border. They have warned Syria to stop the flow of these suicide bombers but no avail. They argue that such a strike would be justified under international law and cite a principle known as “hot pursuit.” The United States could argue, as Israel has done to justify strikes against Hezbollah installations in southern Lebanon, that a limited strike against bases used

by foreign jihadis in Syria would be justified under the principle of anticipatory self-defence, which some legal scholars say is upheld by Article 51 of the UN Charter.

Other experts point to the 1837 Caroline case, in which British and Canadian rebels crossed into U.S. territory and set the steamer Caroline ablaze, killing two Americans in the process. The Americans argued that the British claim of self-defence.

## VII. RESEARCH FINDINGS

Under research findings, four key points were revealed. First is that there is no governing international legal code that recognizes a reflexive right of hot pursuit on land. However, despite of the legality, world powers execute this concept as a practice.

As for example, US hot pursuit in Syria. Also it was revealed that the Principle or doctrine of hot pursuit can only be found under law of the seas and not on land. Also, hot pursuit on land is being enforced by many states wrapped as a 'right' and it is almost used to call as Right to hot pursuit. As per the standpoint of international law experts, there is a recognized right of hot pursuit to pursue ships escaping in international waters but there is no similar global legal authority that would allow one nation to violate another nation's border to pursue an opposing force on land.

However, as discussed earlier, it is evident in many cases that several leading states use hot pursuit on land in their military actions. In addition, by giving out several reasons such as self-defence of the state's hot pursuit on land has been used to veil certain military actions. International law authorizes military action if a nation can show it is acting in self-defence. But not by recognizing that nations have repeatedly invoked their self-interest in striking opposing forces across borders. This was evident during 1837 Caroline case. This further establishes the fact that unlike hot pursuit on sea which pursues on international seas, execution of hot pursuit on land absolutely violates the principles of state's sovereignty and territorial integrity.

## VIII. RECOMMENDATIONS

It is evident with afore discussed points that there is no legally recognized principle of hot pursuit on land even though many states such as U.S. is being implementing such a practice in order to define their military actions. In this backdrop, it is well understood that the principle of hot pursuit on land and principle of right to self-defence of

states are two different principles which cannot be shielded for the sake of another. On the other hand, execution of hot pursuit on land violates the state's sovereignty and territorial integrity.

Therefore, it is recommended that since there is no internationally recognized right to hot pursuit on land it must be prohibited because this is being executed beyond the legality by the world powers. If not, it shall be granted a legal recognition similar as to hot pursuit on seas by world legal regime.

## IX. CONCLUSION

In conclusion, it must be mentioned that principle of hot pursuit on land has become luxury coverage of military actions only to world powers.

Therefore, it is necessary to prohibit the execution of principle of hot pursuit on land because uncertainty of permission to execute has already become a challenge for changing dynamics in the global environment.

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# 21<sup>ST</sup> CENTURY GREAT GAME AND ITS ACTORS: INDIA'S INTERESTS IN CENTRAL ASIA AND ITS REPERCUSSIONS IN SOUTH ASIA

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**Abstract** - In 2012 June India launched a “Connect Central Asia” policy which embodies India’s ardent concern over Central Asian states. This paper will show how this policy would undermine the regional stability of South Asia since Pakistan’s natural fear on Indian involvement in Central Asian region. Robert D. Kaplan points out that India’s history is the story of invasions from a north-westerly direction. Under these circumstances troubled in Central Asia, Afghanistan has become a crucial strategic point for New Delhi. The literature review of the papers is based on the subject matter and this paper will ultimately trace a comprehensive analysis on the repercussion of rising Indian role in Central Asia and how it would create a new “Great Game” in the region.

**Keywords** - Central Asia, Great Game, India, Pakistan

## I. INTRODUCTION

For many of the readers who have read Rudyard Kipling’s “Kim”, word “Great Game” provides a sense of nostalgia which reminds of the historic encounter took place during the British Raj in later part of 19th century and early 20th century. The Anglo Russian rivalry over the hegemony of Central Asia created a storm in tea cup from late 19th Century to early 20th Century which officially ended in 1917. In the days of East India Company in India, British interests were purely confined to financial based such as opium industry and many of the British officials saw the Imperial Russian presence in Caucasus and Central Asia as a threat for their dominance in the region. Peter Hopkirk has aptly described the nature of the rivalry between Imperial Russia and British over Central Asian region and he further argues how British East India Company used its officers to explore the way to borders in Northern India

and manipulate the local tribes. Especially the geographic uniqueness of Central Asia and its strategic position as a buffer zone stimulated both British and Russian interests to stay tune to the game. However as Peter Hopkirk coins in his book “The Great Game-On Secret Service in High Asia” the phase of the rivalry between two nations came to a diplomatic end when Anglo-Russian Treaty in 1907, but even after that the “New Great Game” epoch began to loom as a crucial factor in early 20th Century politics. During this period British paid a heavy concern over Russian activities in Central Asian region, because British

felt the Imperial Tsarist Russia would one day go for an onslaught to India by using Central Asia as a passage and that assumption had feared the English bureaucratic mind since India happened to be the glorious jewel of the Empire. As the old Gibbonian quote goes on “History is indeed little more than the register of the crimes, follies and misfortunes of the mankind” this colonial memory of “Great Game” has been reawaken from its slumber in the history and today in the 21st century the “New Great Game” narrates a different story through its age long historic saga in Central Asia.

## II. NATURE OF NEW GREAT GAME IN 21<sup>ST</sup> CENTURY

Unlike its old type the nature of Great Game has been changed with many ups and downs occurred in the past century. Especially it is important to trace the historic events which took place after the British departure from the region, because the understanding cold war context is highly necessary to understand the nature and players of “New Great Game” in 21st Century.

When British took off the Union Jack from India, they did it with creating two nation's states in the sub-continent called India and Pakistan. Post India's relationship with Central Asia was highly nurtured by New Delhi's closeness with Kremlin and it played a crucial in Indian attitude towards the region. Historically India's past has been intertwined with Central Asia since the day of yore. For an instance, land silk route used to be an important line of diplomacy in the past where not only trade took place, but many of the intellectual ideas, war strategies were exchanged. This geographic intimacy between the two regions began to sharpen after British left from the region. But it never took place in a rapid manner, instead of India's presence in Central Asia developed under the Soviet influence till the collapse of USSR in 1991. After its defeat by Chinese in Indo-Sino war in 1961, India realized the importance of keeping its hawk eye on Central Asia, because the unique geographic position of Central Asia could have made pivotal impacts in Indian soil. However the necessity of playing a "New Great Game" never emerged till the beginning of present century and Indian power was not in a highest position in world politics, but the collapse of Soviet Union and Delhi's favorable attitude towards Washington had played the cards of the game. It is a fact beyond dispute the USA has shown a pragmatically positive attitude towards Indian power in South Asian region recently.

International Relations scholar Ivan Campbell argues that by allowing India to expand its wings around Central Asia, Washington eventually expects to implement a strategy that this New Silk Road would link India with Central Asia and then it will be a path to the west. The US involvement in the region was highly galvanized by its operation in Afghanistan after September 11 attacks; it finally set up the ground for the US to enter, but its interests in the Central Asian affair is highly under covered by the Indian presence. According to Stephan Blank "Washington's presence allows India to play or at least aspire to a greater Central Asian role than it could achieve on its own". For many Security strategists this a scrumptious game played by the USA after using India as its proxy. Nevertheless the motives of Indian desire over its "near abroad" has deeply upset India's biggest nemesis in South Asia, Pakistan and also the Chinese too feel quite uneasy before this new "Great Game" of the 21st Century. By looking at the nature, it becomes a palpable fact to realize that unlike the old "Great Game" of the British Raj, this wouldn't be an old fashioned game between two parties. But the contemporary political context in Central Asia and the world has completely changed its nature.

### A. It's Actors and Their Roles

Robert De Kaplan states in his writing that India's history is the "story of invasions from a North-Westerly direction", under this circumstance for philistine Indian eyes Central Asia becomes a source of threats than opportunities. It is a known factor that after the humiliating defeat by Chinese in 1962, Indian-China relationship continues doldrums and both countries have adopted a skeptical attitude towards each country. When looking at the annals of history, it is a pretty interesting factor to recognize that Indian interests in Central Asia was relatively less before the collapse of Soviet Union and the region was shadowed by Russians as it used to be in the 19th Century. But the in the advent of post-cold war era both the Indian and Chinese interests of Central Asia sprang out and especially both the cultures do share various affinities towards Central Asia. When it comes to Afghanistan and Iran, India does have a closer role and China has its odds from the remote Central Asian states like Azerbaijan, Turkmenistan. Besides having such socio cultural affiliations with China and India, it is a pivotal fact to remember that in this 21st Century Great Game no Central Asian state is expected to play the role of a "Pawn". But they rather are independent actors that have a narrow margin to maneuver against their Russian, Chinese and Indian neighbours but are still independent in their foreign policy decisions. More importantly Central Asian states do not have same allegiance to either China or India, it differs from the above mentioned socio cultural affiliations.

However, despite its blooming importance Central Asia continues to be a peripheral region in terms of security. For China the stability of Turkmenistan will be extremely important with the growing unrest in Xinajiang and on the contrary the Afghan peace becomes more relevant with India to keep its thumb in Kashmir from Islam extremism. Both countries have been grappling with the Islamic extremism in certain ways and it creates a heavy concern over the security in Central Asia. Afghanistan remains the fragile state in Central Asia which has so many security loopholes and especially its instability became worsen after the NATO departure from Afghanistan in 2014. Ostensibly security matters a lot for India to work with the Central Asian region. Apart from the security concern it is clear enough the other interests loom before the region and actors of the "New Great Game" have set up themselves to play the uncanny game. In 21st Century energy security has become a paramount fact in deciding the power of a nation state. Securing an assured and uninterrupted supply of energy is must for India's economic wheels in motion.

According to the current data analysis India's present energy sources are mainly coming from abroad, especially from the "chop and changed" Middle East region. Central Asia has God-given richness in natural resources and Caspian Sea grants off-shore hydrocarbon to the region. 4 percent of natural gas and 3 percent of the world oil reserves have been confined within this part of the world. Kazakhstan, Turkmenistan, and Uzbekistan possess most of these resources. Being a nuclear power India strives to increase its uranium assets and Central Asia provides a fabulous space for such a task. For an instance India-owned Oil and Natural Gas Cooperation (ONGS) has planned to invest in Kazakhstan, which possesses the world's most fertile oil fields. Ironically India is not the only actor who shows an ardent interest in the rich energy resources of the Central Asian region. China too has a flare over the energy sources in Central Asia and Chinese have been investing in the region by keeping a good tally with India.

In order to keep the good faith many of the Central Asian states attempt to uphold a cordial relationship with both the countries, but factually each one has its own allegiances. As the given paragraph mentioned both China and India having their own cards in the region and geo-political security and energy security have become the larger ostensible interests in India and China. But it is not a prudent fact to isolate "New Great Game" as a geo-political encounter between two emerging super powers, because by looking at the depth of the game one could see the spider web of Great Game has crossed the Atlantic Ocean and penetrated the walls of White House.

### **B. Geopolitical Relations of India in "New Great Game"**

International Relations analyst Ivan Campbell has pointed out in a magazine which was published in 2013 October how India has started its recent developments in Central Asian region through strengthening the formal foreign relationship. It was in 2012 January that New Delhi launched its "Connect Central Asia Policy", this intended to build a stable and strong relationship with India and the fellow states in Central Asia. Campbell argues the ulterior motive of creating such a harmonized stability meant for a wave of expansion of Indian influence over Central Asia, eventually it would seek fortune for India such as supplying energy security as well as India investments in Central Asia would tie Indian influence over the region. Moreover the geopolitical relations between India and other states in South Asia, especially Afghanistan and Pakistan will become more significant regarding deciding the nature of "New Great Game".

It is not an exaggeration to mention the fact that existence of Pakistan always has been the nemesis of modern Indian history. These two nations have fought three times with each other and India's access to Central Asia becomes trivial, because Pakistan's geography always hinders direct India approach to the region. On the other hand the much troubled state in Central Asia, Afghanistan plays a crucial role in this context. For some Indian minds still Afghanistan is an integral part of the Indian subcontinent, but its instability always has shocked the policy makers in New Delhi, because if Afghanistan's rule again falls back to Taliban or any other Islamic militia, it would be a severe blow on India's national interests. However in the recent past India has shown a progressive interest in Afghanistan's politics, even in the previous government of Karzai and current rule of president Ghani. In the point of matter India now strongly backs the rule in Kabul as a bulwark against Pakistan as India used to be during Najibullah's era. By looking at Indian factor in the politics of Afghanistan one cannot forget the US recent past with the same country.

Present circumstances are clear enough to understand that Washington expects New Delhi to play the Viceroy's role in Afghanistan after the departure of American military in the region. US international relations analyst Robert D Kaplan has aptly shown the new American interest in India to play a larger role in the Central Asia. He states "As the USA and China become the great power rivals, the direction in which India tilts could determine the course of geopolitics of Eurasia in the 21st Century. India and other words loom as the ultimate pivot state". But this Indo American alliance in the 21st century Central Asian politics leads to a further chaotic situation in Pakistan, which used to be the strongest ally in South Asia for the US, when New Delhi dined with Kremlin in the period of Cold War. The inevitable outcome of such an alliance is Pakistan is approaching more towards the China. The recent Chinese involvement in establishing China-Pakistan Economic Corridor (CPEC) is a reflection of this scenario. There is no doubt this China's new Silk Road will rapidly alter the regional dynamics of trade, developments and politics.

### **C. Repercussions in South Asia**

India's new interest in the Geopolitics of Central Asia has longer consequences in South Asian politics. Being the key access to South Asia Central Asian region has a greater importance in South Asia despite its number of socio-cultural differences. Especially the relevance

of the context has to be understood according to the hegemonic role played by India in South Asia. It is a fact beyond dispute that India has improved a tremendous political and economic strength in the recent past and especially its ties with the USA makes ponderable impacts in the regional affairs. Once Undersecretary to the US State Department Nicholas Burns predicted "Within a generation many Americans may view India as one of our two or three strategic partners" This new tendency has critically changed the fate of South Asia today and "New Great Game" looms as a new dimension of Indo-American alliance. The first half of this paper has dealt with the question how American attempt to meddle with the "Geo Politics" of Central Asia through using India as its proxy, and it is certain enough that such a companionship in Central Asia will make Chinese uneasy, at the same time it can boomerang upon India in South Asia as a form of Chinese- Pakistan axis. A

s this paper illustrated Chinese will use states in South Asia to hinder Indian plan to approach Central Asia and in such an event Pakistan will be an ideal ground for Chinese. Moreover it further tries to expand its stable relationships with Nepal and other South Asian countries, in such an event India will get encircled by pro Chinese states in the home ground. For both the states do have a civilizational romance with the Central Asia with its old myth called "Silk Route", which had left many influence over the history of both countries. Under these circumstances China will continue a mechanism to pressurize India from South Asian block to Prevent Indian power rise in Central Asia. Staunch Chinese involvement in Pakistan and Nepal could be taken as ideal examples to prove this contention. Moreover China shows an interest in the maritime activities in the Indian Ocean, especially during the regime of Mahinda Rajapakshe of Sri Lanka, China involved in serious projects in Sri Lanka to revive the "Maritime Silk Route" in Indian Ocean by investigating a huge amount of finance over constructing Hambatota International harbor in the Deep South part of Sri Lanka. Indian International Relations analyst N. Manoharan argues

"If China wishes it can always turn these projects to India's disadvantage in a conflict situation". These factual circumstances are enough to assume that India's interest in Central Asia can boomerang upon them in the home ground because Chinese becomes more sceptical on India's presence in Central Asia and then in order to balance the situation they would befriend with all India neighbours and it will spontaneously lead to a greater power imbalance in the region. On the other hand the U.S

concerns about the rise of Chinese power in the Central Asia as a ponderable factor in their diplomacy. The scale of potential Chinese investments projects in Central Asia betrays an ambition for expanded economic influence over the region.

It was in 2013 that Beijing declared they would provide \$64 Billion in infrastructure deals in the region. These plans were followed in 2015 by Chinese president Xi Jinping's announcement of the ambitious Silk Road Economic belt initiative, also many Western scholars have already predicted the Shanghai Cooperation Organization (SCO), which comprises China, Russia and all the states of Central Asia except Turkmenistan has credible potential to become a powerful regional entity like European Union in the coming years. By nature the U.S is reluctant to bear such a situation and it has been evident it recent policy changes towards Central Asia that Washington will succour and accept Indian presence in Central Asia as a strategy against China. But its longer consequences will last for a long time while making a political unrest in South Asia.

### III.CONCLUSION

This paper has traced the historic analogy of 21st Century 'Great Game' since its inception of the post-cold war era. India's new approach towards Central Asia CCAP has more expectations such as energy security, geographic strategies etc. However New Delhi's launched campaign on Central Asia in 2012 will envisage many challenges to implement in Central Asian soil as this paper pointed out in the above mentioned arguments. The eccentric nature of this "New Great Game" is unlike its old model which existed between the British raj and Tsarist Russia; the new encounter will entangle number of states together in action, as Marlene Laruelle rightly pointed out "The fellow states of Central Asia will not play the role of mere Pawn States. They rather be actors in the game".

The question arises when India tightens her role in such a fervent manner in Central Asia, its repercussions can penetrate the boundaries of South Asia too. As this paper has analysed Indo American affinity with regard to the spreading influence in Central Asia can always create a clamour in Chinese psyche and in order to prevent further Indian expansion near their home frontier China will increase its cooperation with Indian neighbours strongly, ultimately this dilemma of power lead to an inevitable regional crisis of South Asia. As Chanakya aptly said in his famous treaties on state craft it is always the failure of

diplomacy which leads to the war. This maxim is heavily applicable to the context in Central Asia. In the grand old days of old “Great Game” in the Raj, Anglo-Russian rivalry was all the time tamed by the good diplomacy and mutual negotiations and it is still early enough to predict the outcome of the “New Great Game” in 21st Century.

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# THE POST DEPLOYMENT REINTEGRATION AND MENTAL HEALTH ISSUES OF THE SRI LANKAN ARMY SOLDIERS; A SITUATIONAL ANALYSIS IN THE POST CONFLICT CONTEXT OF SRI LANKA

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**Abstract** - This study examines the phenomenon of mental health status of the Sri Lankan Army Soldiers in the Post Deployment Reintegration stage and how their mental health status affects the self-development, professional life, family life, social life and functional level of the Army Soldier. Further, the researcher explores the existing and prevailing Post Deployment Reintegration Programs and the mental health services being adopted in the Sri Lankan Army. Also, the researcher assesses and evaluates how negative perceptions and pressures emanated from the general civil society affect the mental health status of the aforementioned Army Soldiers. The experimental design adopted for the study is Cross Sectional Research design which is of descriptive in nature. The Sri Lankan Army, being the main study area, is the population of this study. Out of such population, the researcher selected a sample of 40 soldiers with bitter experience of war from three Army Camps where purposive sampling method was applied. Primary data were gathered mainly through qualitative means including four case studies targeting lower rank Army officers.

Although the Sri Lankan Army Soldiers had faced with very strenuous, cumbersome, life threatening and tragic situations during 30 year war time, the mental health status of the Sri Lankan Army Soldiers was found to be satisfactory. Moreover, being the employer organization, the guardian and the closest relative of the soldiers and their family members, Sri Lankan Army implements a

host of medical and non-medical welfare programmes to safeguard and uplift the mental health status of the Army Soldiers. On the other hand, It was evident that the civil society's positive perception towards one time martyrs is fading away gradually due to various negative behavioural patterns of some of the absent and in-service soldiers which reflect very badly on the entire civil society. In addition, labelling and stigma were also proved to be in existence among soldier community.

**Keywords** - Post Deployment Reintegration, Mental Health Issues, Sri Lankan Army Soldiers, Post Conflict Context

## I. INTRODUCTION

'Conflict' has many meanings in everyday life. To some it refers to behaviour or action. (Wallensteen, 2007) Deep inside every conflict lies a contradiction, something standing in the way of something else. (Galtung, 2003) This implies, why this behaviour or action occurred, throughout the history to the present era. The consequences of the conflict can be both positive and negative. Therefore, when considered the present conflict situations, humans are more concerned on how to minimize the negative impacts of the conflict. This research report brings forth such a specific aspect to the readers' attention.

The focus of this research study is to examine the mental health status of the Sri Lankan Army soldiers in the post deployment reintegration. Thus, the focal point of the study, the Sri Lankan Armed Forces consist of three main strands as; Sri Lankan Army, Sri Lankan Navy and Sri Lankan Air Force.

These three Armed Forces are the three main pillars of the Sri Lankan Government Security System which is also can be considered as the backbone of such system. Accordingly, out of the three Armed Forces mentioned above, the Sri Lankan Army, being the largest Armed Force in Sri Lanka has been playing a very vital role in protecting the sovereignty of the country.

In its history of 65 years, the hardest and most precarious time the Sri Lankan Army had to undergo was to face the civil war waged by the LTTE (Liberation Tigers of Tamil Eelam) in the Northern and the Eastern part of the country, for 30 years.

After battling with LTTEs, the Sri Lankan Army was able to defeat and crush the rebels in May, 2009 winning all accolades to its credit. Now, according to the professional conflict analysts Sri Lanka is in the Post Conflict Stage facing unprecedented, host of challenges to be solved by the authorities in Armed Forces.

The Sri Lankan Army Forces being the main Armed Force engaged in the land based military missions during the internal conflict period of Sri Lanka, faced with various traumatic experiences. These traumatic experiences affected the Sri Lankan Army and the Sri Lankan Army soldiers in diverse ways in the post conflict context.

The researcher having understood the importance of this issue socially and nationally, gathered information first hand and in addition, collected data and other information using other primary and secondary means and conducted a situational analysis in this Post Conflict Stage, on the Post deployment reintegration and the Mental Health status of the Sri Lankan Army soldiers.

The specific objectives of the study are as follows; to study the mental health status of the Sri Lankan Army soldiers and its impact over the Army soldier, to evaluate the family, extended family, workplace and civil society, impact over the mental health status of the Army soldiers, to reveal the mental health services provided by the Sri Lankan Army, to provide suggestions and recommendations for the improvement of the post deployment reintegration program of the Sri Lankan Army.

## II. METHODOLOGY

The researcher used the descriptive research study method to explain the diverse of information collected for the research study. Further, during the data collection process, priority was given mainly to gather qualitative data.

“Health care practitioners, managers and policy-makers have increasingly turned to the qualitative methods of social inquiry used within the social sciences to enhance understanding of health services and to improve the management and provision of health services”. (Green & Thorogood, 2004) On the other hand, as it has been pointed out by Royse (1991), “The qualitative researcher seeks to understand social relationships and patterns of interaction and qualitative research is commonly regarded as being exploratory”.

The researcher was able to find that the Sri Lankan Army soldiers and the officials of the Sri Lankan Army carry various in depth perceptions, behaviour patterns, opinions and life styles which affect the mental health status and the Post Deployment Reintegration of the Sri Lankan Army soldiers. Further, the research study focused mainly on the mental health status of the soldiers, the behaviour of the other social systems related to the Army soldiers, the mental health services provided by the Sri Lankan Army for the Army soldiers.

Going by the conclusion given by Pant (2010) as “The researcher’s purpose is to study these perceptions and, thus, gain a greater insight and knowledge on the study area”. Non experimental research design was utilized throughout the study since the study will not involve a manipulation of the situation, circumstances or experiences of participants. To gather data in-depth interviews, observations, key informant interviews and case study methods were used by the researcher.

Under in-depth interviews the information gathering sections were mainly divided in to seven main topics as demographics and personal information, front line experiences, self-development, the relationship with the family members, information related to the health, relationship with the spouse and the children, reintegration programs and the participation. Non participatory observation approach was utilized by the researcher as an observatory method during the interview. When interviewing the key Informants the questionnaire was designed considering the nature and the type of the key informant and the researchers intended study requirements. Further, four Case Studies were conducted with selected respondents to strengthen the study.

The collected data and facts were converted to meaningful information. Further, such information was sorted and studied in depth. Then, the researcher interpreted the findings and results through the calculation of averages, percentages using the SPSS statistical data analysing software. Thereafter, the findings were presented in a descriptive manner.

### III. EXPERIMENTAL DESIGN

The Sri Lankan Army, being the main study area, is the population of this research study. Having total man power strength of around 276,700 personnel, the Sri Lankan Army consists of 24 Regiments and Corps dispersed all around the island. The researcher selected three Army Camps as Sinha Regiment, Gemunu Watch and Panagoda Cantonment, the sample of the study.

The nature of the research study is Qualitative. Further, primary and secondary data were gathered to support this research study.

As mentioned above, to gather the primary data, 40 in depth interviews, observations (all the respondents who participate in the study), 4 case studies, 10 key informant interviews were conducted with the higher level officers of the Sri Lankan Army mainly covering the three camps mentioned above and consultant psychiatrist of the Sri Lanka Army Hospital, Colombo, and counsellors of the Sri Lankan Army hospitals.

As secondary data of the study, locally and internationally published Journal articles, publications and research reports conducted on the theme of mental health, post deployment reintegration were referred by the researcher.

### IV. RESULTS

Regarding the mental health, the scholar Sreevani (2010) has quoted in her book titled “A Guide to Mental Health and Psychiatric Nursing” the definition given by The American Psychiatric Association (APA 1980) for Mental Health as, “Simultaneous success at working, loving and creating with the capacity for mature and flexible resolution of conflicts between instincts, conscience, important other people and reality.” To explain Post Deployment Reintegration in brief, it is the stage where the Army soldiers will re-enter the family and the society from the military context.

Self-Development of the Army Soldiers were examined through their Personal, Professional, Economical and Intellectual development. As a percentage, 65 percent (26 participants) agreed that there was a Personal

Development such as entering for matrimonial stage, spouse giving birth to offspring. Also, 35 percent (14) mentioned that there were no any Personal Developments in their lives for the past six months to one year. As a percentage, 80 percent (32) of the soldiers agreed that there was Professional Development and 20 percent (8) of the soldiers mentioned that they did not have any Professional Development. Regarding the Economic Development, 72.5 percent (29) of the soldiers mentioned that they had an Economic Development while 27.5 percent (11) of the soldiers said ‘No’ Economic Development in their lives. As a percentage, 50 percent (20) of the soldiers agreed that they were able to have an Intellectual Development while 50 percent (20) of the soldiers mentioned that they were unable to have an intellectual development for the past six months to one year.

As per the World Health Organization’s document titled, World Health Report 2001 – Mental health: New Understanding, New Hope, ‘10% of the people who experience traumatic events will have serious mental health problems and another 10% will develop behaviour that will hinder their ability to function effectively. The most common conditions are depression, anxiety and psychosomatic problems such as insomnia, or back and stomach aches.’

Findings	Yes	No	Sometimes	Percentage
Feeling guilty on the carried out military activities	6	29	5	15
Tobacco Consumption	6	22	12	
Alcohol Consumption	1	7	32	
Job Satisfaction	34	0	6	
Changing the Job	4	31	5	
Appreciation received by SL Army	32	1	7	
Appreciation received by Civil Society	18	5	17	

**Table 1. The Responses under the categories; feeling guilty, tobacco use, alcohol use, Job satisfaction, changing jobs, appreciation received by SL Army and Civil society.**



Similarly, the researcher was able to identify a set of experiences which was common among all the forty respondents. Such experiences are as; being attacked or ambushed by enemy, receiving incoming artillery, rocket or mortar fire, receiving small arms fire, shooting or directing fire at the enemy, being responsible for a death of an enemy combatant, seeing dead bodies or human remains, handling or uncovering human remains, seeing dead or seriously injured fellow soldiers, being wounded or seriously injured to himself, having a close call, shot or hit, but protective gear saving the soldier, having a buddy shot or hit near the soldier, engaging in hand to hand combat and saving the lives of civilians or soldiers.

Further, the soldiers mentioned that the military actions in which they were engaged were common, universally practiced military actions that any military around the world would face with and the strategies and the techniques adopted while being in action were always to protect the civilians and the sovereignty of Sri Lanka.

During the Humanitarian Mission, the decision makings have been directed to them daily and such decisions had been in line with the final objectives of the mission. It is visible that the decisions were always taken by the superiors and Army soldiers had only put the decisions in to action. Therefore, the soldiers mentioned that they are not feeling guilty and their performance during the Humanitarian Mission does not affect their mental health status negatively.

The researcher found that none of the respondents have a family history of psychiatric or mental illness. Further, the respondents mentioned that they had not taken any treatment for any psychiatric or mental illness prior to the deployment, throughout the deployment or in the present post deployment stage.

Further, Out of all the respondents, 67.5 percent (27) of the respondents mentioned that they had not received any medical treatments for the past six months' time period while 32.5 percent (13) of the respondents mentioned that they had received medical treatment for various physical problems caused by battle ground induced wounds and injuries which in turn induced disability. Only one respondent mentioned that he was taking treatment for high blood pressure and cholesterol.

According to the collected data, 57.5 percent (23) of the soldiers mentioned that they were not getting aggressive in both personal and professional life matters while 42.5 percent (13) of the soldiers mentioned that they were

getting aggressive. Yet, they have the ability to cope up with the aggression. When asked to explain instances of healthy coping mechanisms of the Army soldiers, they pointed out as; keeping silent; talking to a loved one such as mother, leaving the aggression induced situation & place etc.

Out of all the respondents, 52.5 percent (21) of the soldiers have joined the Sri Lankan Army by considering it as a better job opportunity where 25 percent (10) has joined as a service for the country. Further, 15 percent (6) has joined due to the family back ground where the father or other relatives have previously worked or working in the military service. As a percentage, 7.5 percent (3) of the soldiers mentioned that they had joined the army because of other reasons such as passion and interest for working in the Sri Lankan Army.

Furthermore, 87.5 percent (35) of the soldiers mentioned that they were satisfied about their service since it was meant for the Sri Lankan Army and in turn, for their motherland. Also, they mentioned that they were highly satisfied with their jobs and they enjoyed with what they were doing. Apart from that it was found that they were confident and happy for working in the Sri Lankan Army. In the meantime, 12.5 percent (5) of the soldiers mentioned that they were satisfied sometimes about their service for the country and for the Sri Lankan Army.

Adding the above fact, 60 percent of respondents (24) mentioned that they had a very good relationship with their friends while 37.5 percent of the soldiers (15) mentioned that their relationship was good with the friends. Further, 2.5 percent (1) agreed that to a certain extent, their relationship with friends was good.

Through the in-depth interviews and the key informant interviews conducted, the researcher found that the Sri Lankan Army does not conduct a Mental Health Screening Process for the new recruitments; the Army Soldiers do not take part in a Mental Health Screening Process during the Pre deployment stage, Deployment stage and even in the Post deployment times. Thus, a writer to The New York Times, James DAO states in his online article Military Study find Benefits in Mental Health Screening had pointed out that, "Soldiers who were screened for mental health problems before deploying to Iraq were less likely to report suicidal thoughts, be evacuated for mental health reasons or require care for combat stress."

During the study, the researcher drew the attention on the Basic Recruitment Training (BRT) of the Sri Lankan Army which is yet another important aspect of Professional Life. According to the findings gathered from the respondents,

they believe that the Sri Lankan Army procedures are somewhat different to the better from those of the other Militaries around the world. As per the BRT given by the Sri Lankan Army, soldiers undergo an initial training program for four to six months' time. Then, thereafter, upon the deployment to a particular Unit, the soldiers receive a fourteen days Unit specific training. The BRT which is been carried out by the Sri Lankan Army is very effective as it shapes up an Army soldier enabling them to face the military setting. Furthermore, it builds up the coping skills, emotional control, personality, self-esteem and the patience of the Army Soldier. Apart from that, this training imparts knowledge on civil administration to while contributing positively for the mental health of soldiers. According to the soldiers, the BRT provides a strong footing to the soldiers to get the basic shaping to fit for the Military Profession. Though the BRT does not include programs or activities specifically targeting the mental health status of the soldiers, the soldiers mentioned that BRT addresses the mental health aspects too. Due to the intense qualities of the BRT, the individuals who are unable to cope up with the BRT leaves the Sri Lankan Army during this four to six months' time period. Therefore, the BRT is very important since everything in a soldier's life will depend on such an acute training.

During the deployment of the soldiers in the conflict, the family members were anxious about the soldiers' lives and it was a very stressful time period for both parties considering the repercussions of the war. Soldiers further noted that the wives were very cooperative during the deployment time period and also, during this post deployment reintegration time period during which this study was conducted. Though it was difficult for the Army Soldiers to communicate with the families during the deployment, both parties had the mutual understanding about their relationship and about the very nature of the military profession. Therefore, they managed to continue with their relationship strongly and in a very stable condition. They also mentioned that the high ranking officers gave them the maximum opportunity to have contacts with the family members and if there was any urgent need, the soldiers were given the opportunity to visit the family members as well. Adding to the facts mentioned above, the respondents stated that, in the post deployment reintegration also they were able to maintain a healthy relationship with their families due to the mutual understanding of both parties. The researcher was also unearthed that most of the soldiers and their wives had the healthy problem solving skills to overcome diverse of their day to day problems. Further, if a third party intervention

was needed such as counselling or legal support, the Sri Lankan Army had provided those needed services for the Army soldiers and their family members too. In the present post conflict context, they have the ability to spend more time with their family members.

In the post deployment reintegration, most of the Army soldiers incline to give more attention to their children to strengthen those relationships by spending more time with them, taking them to school, attending to children's school home-work, playing with the children etc. Such behaviour patterns of soldiers have helped to strengthen the relationship between the father and the offspring immensely. Also, this has resulted in uplifting the mental health status of the Army soldiers in the post deployment reintegration.

The Army soldiers were hopeful and had plans about their future which was mostly related to family members such as providing a good education to their children and groom the children to be good citizens, building or complete building of their homes, complete the Army soldiers' education related programs etc. Furthermore, the soldiers those who were going on retirement mentioned that they were planning to start businesses, find new job opportunities; fly abroad for income generation etc.

As a percentage, 77.5 percent (31) of the soldiers agreed that their relationship with the extended family members was very good while 22.5 percent of the soldiers (9) mentioned that their relationship was good with the extended family members. Further, 75 percent of the respondents (30) mentioned that the Army soldiers had the ability and capacity to provide support for the extended family members. In the meantime, 25 percent of the soldiers (10) mentioned that to a certain extent they were providing support and had the ability and capacity to support their extended family. Also, it was visible that some extended families were living close to the soldier's family or living with the soldier and his family, visit the extended families either weekly or monthly, provide financial support to the parents and taking care of the elderly relatives providing medical needs as well. In the Asian context, extended family has both positive and negative influences for a nuclear family.

As a percentage, 45 percent of the respondents (18) mentioned that they were satisfied with the appreciation they received from the civil society while 42.5 percent of the respondents (17) mentioned that they were somewhat satisfied in that regard. Further, 12.5 percent of the soldiers

(5) mentioned that they were not satisfied with the civil society appreciation. As a whole, all the respondents agreed that the respect and the appreciation they receive from the civil society is reducing gradually as now the conflicting experience is fading away. Adding further, the respondents also mentioned that the unaccepted behaviour of some handful of Army Soldiers has induced this situation among the civil society.

Further, the gathered information signalled the following important facts as well. The Army soldiers are in the post deployment reintegration where they will not be engaged in any specific military activities or missions. But, the Government of Sri Lanka and the Ministry of Defense have allocated a huge amount of funds in the annual Sri Lankan budget under military expenditure. Due to the facts mentioned above, the civil society believes that the Sri Lankan Army is not engaging in any productive work and they have simply become a burden to the society.

When analysed these information, it was visible that this situation is creating negative image in the Army soldiers' mental health status. The Army Soldiers mentioned that this situation reduced the motivation of the Army Soldier since it affected the self-esteem, dignity and enthusiasm.

All the respondents mentioned that they had both civil and workstation category of friends. Some also mentioned that they preferred to have friends from the civil society since they do not need to talk about the official or the military activities with such civil society members.

The other point the researcher examined is about the status of Army Soldiers entering to matrimonial state, which is the basic system of the society. As a percentage, 97.5 percent of the Sri Lankan Army soldiers (39) participated for the research study is married while 2.5 percent (1) of the soldiers are unmarried. Further, 67.5 percent (27) of the soldiers got married before the year 2009 where the conflict was ended. On the other hand, 30 percent (12) got married after the year 2009. Also, 2.5 percent of the soldiers (1) are not yet married. Marriage being the basic social system or the unit of the society, it was visible that all the Army soldiers are related to and they directly experience this social system.

As a percentage, 82.5 percent of the soldiers (33) mentioned that it is important that the Sri Lankan Army should introduce the mental health related programs while 7.5 percent of the soldiers (3) mentioned that it is not that much important. Further, 10 percent of the soldiers (4)

had no opinion over the question. Responding further on this matter the soldiers mentioned that at present, Sri Lankan Army has several programs such as; religious programs; meditation sessions, programs of observing sill targeting stress management. In addition, the Army Hospital conducted awareness programs, vocational training, development courses, counseling courses, positive thinking courses, family therapy sessions etc. for the benefit of the soldiers. Furthermore, accessibility for the mental health services inside the Sri Lankan Army has been improved vastly.

Yet, as a whole, the respondents agreed that it was also important to upgrade the existing mental health related programs in the Sri Lankan Army. Further, stigma and labelling towards mental health should be reduced in the Sri Lankan Army since stigma and labelling is the main impediment for the mental health services to be improved in the Sri Lankan Army. Further, it is also a good reason for Army soldiers to be reluctant to receive the benefits of these services.

At the end of the internal conflict in the year 2009, 50 percent of the soldiers (20) mentioned that they were deployed for another camp setting, and 22.5 percent of the soldiers (9) mentioned that they were sent on official leave. As a proportion, 22.5 percent of the soldiers (9) mentioned that they remained in the front line and engaged in the clearing activities while 5 percent of the soldiers (2) mentioned that they engaged in a Post Deployment Reintegration Program. However, as commented by the respondents, the Post Deployment Reintegration Programs carried out by the Sri Lankan Army are not accurately organized and such programs are not provided for all the Army soldiers too.

Responding further in this regard, 80 percent of the soldiers (32) mentioned that they preferred a Post Deployment Reintegration Program and they were of the opinion that it is important to have a Post Deployment Reintegration Program in the Sri Lankan Army for all the Army Soldiers. Meanwhile, 10 percent of the soldiers (4) mentioned that they were not in need of a Post Deployment Reintegration Program. On the other hand, 10 percent of the soldiers (4) mentioned that they had no opinion about it.

Furthermore, the respondents suggested that a Post Deployment Reintegration Program should be provided for the absent soldiers of the Sri Lankan Army. Also, they believe it is not a prudent decision to enroll the absent soldiers again for the Sri Lankan Army. Yet, the absent

soldiers should be provided with a proper Reintegration Program since it would help them to reintegrate with the society and family successfully.

## V. DISCUSSION

Out of all the respondents, it was visible that the four main development areas of an individual, such as Personal Development, Professional Development, Economic Development and Intellectual Development were above 50 percent which depicts a satisfactory self-development of the Army soldiers.

Yet, it is visible that the soldiers tried to get the coverage of certain beliefs and used the same as a shield to safeguard their mental health status from being harmed by their commissions in actions in the battle ground. The researcher felt that, the soldiers are using psychological defense mechanisms such as Repression and Denial.

As it has been pointed out by Grohol (2007) in the Online Article 15 Common Defense Mechanisms, 'Repression is the unconscious blocking of unacceptable thoughts feelings and impulses. The key to repression is that people do it unconsciously...' The researcher believed the defense mechanisms are used as coping mechanism of various traumatic experiences that the soldiers have faced during the deployment. Use of defense mechanism is good, yet it is important to introduce healthy defense mechanism for the soldiers to be more productive in their lives. Further, when examined the alcohol consumption and the tobacco use of the Army soldiers, it is visible that none smokers are high in smoking category while occasional drinkers are high in drinking category in the Sri Lankan Army.

When considering the global context and similar Military Post Deployments around the world, generally, the military personnel prefer to change their profession once they are in the Post Deployment Reintegration. As it has been pointed out by the scholars that is due to one or more of the following reasons as; excessive workplace burnout, dissatisfaction on the assigned duties and responsibilities at the cantonment setting which are not relating to military activities, dissatisfaction towards his/her performance rendered to the employer and the workstation and the poor mental health status. Such situation is not visible among the Sri Lankan Army personnel at all. As the researcher was appraised of by the participants with proofs, this is due to reasons such as; the Army soldiers' commitment to the employer, the country and their fellow citizens, self-esteem and bondage and respect towards the profession,

the opportunities, benefits and perquisites provided by the employer. When matched this sort of characteristics and behaviour patterns with those of the global situations, it is quite obvious that Sri Lankan condition is in contrary to global situations.

Through the gathered details, it was proven that the extended families of the Sri Lankan Army soldiers have a satisfactory relationship where it provides a moral support, sense of security, belongingness, helpfulness for the Army soldier and for his family. This affects positively the mental health status of the Army soldier which helped them perform their duties in the field.

Furthermore, the statistics imply that the civil society perception towards the Sri Lankan Army soldier is satisfactory, showing that civil society members are eager to have bondages with the soldiers. The Army soldiers are social being those who have the ability to maintain good social relationships. Most of the Army soldiers have entered the matrimonial status and they are experiencing the basic social system 'Family'. It further signifies the social system perception toward the Army soldiers and Sri Lankan Army in general. Further, it was found that the civil society has not stigmatized or labelled the Role of the Army soldier in a negative way. Further, it also depicts the employee friendly initiatives the GoSL and the Sri Lankan Army are practicing toward the Army soldiers, unlike the LTTE leadership towards the LTTE combatants where their carders had been prohibited to have such connections. Therefore, these factors have contributed positively to the Army Soldiers to enter the matrimonial stage easily.

Though the Army soldiers received respect and appreciation from the civil society it is gradually decreasing and there is an increase of negative perceptions among the civil society. Therefore, these negative perceptions of the civil society should be positively addressed by the Sri Lankan Army.

Hence, the Post Deployment Reintegration programs should focus on stimulating the Army Soldiers since it will support and benefit to decrease memories of the war and on the other hand it will inspire the soldiers. It was also observable that the mentalities of the soldiers are still war or conflict oriented. In addition, it was proved that a structured Post Deployment Reintegration Program is important for the Sri Lankan Army Soldiers and for the soldiers those who have absconded from the Sri Lankan Army.

## VI. CONCLUSION

As a whole, the researcher found that the mental health status of the Sri Lankan Army Soldiers in the Post Deployment Reintegration is satisfactory. To achieve such status, their organization the Sri Lankan Army and the closely knitted family members of the relevant soldiers have provided a genuine support, during the pre-deployment, deployment and post deployment reintegration. Yet, the civil society positive perception about the Army soldiers is fading away little by little and due to change of attitudes of the general public towards the Sri Lankan Army.

Labelling and stigma towards mental health prevails among the Sri Lankan Army soldiers. Therefore, this situation discourages the Army soldiers to seek support and services related to mental health. Further, seeking mental health services hinder the chances of aspiring higher career goals in Sri Lankan Army which again discourages the Army soldiers to seek support and services.

Additionally, the findings validated during the recruitment, pre deployments, during the mission deployments or post deployments standard Mental Health Screening Procedures are not utilized. Accordingly, only a set of Army soldiers have received a structured Post Deployment Reintegration Program. Further, burnout in the professional setting is at a rise where the effectiveness of the Army Soldiers threatened since they are in the fashion of not taking at least the assigned leaves being workaholic. Furthermore, it was visible that there is a correlation between the level of education of the Army soldier and the coping ability for mental health related issues. This situation leads where the Army soldiers are utilizing negative coping mechanisms to face the mental health issues frequently.

Further, the Army soldiers those who are coming under the disability category are dissatisfied on the provided attention and benefits to them and their family members. Further, the Army Soldiers those who are retiring from the Sri Lankan Army after a successful professional life is anxious since their skill development is less where it will be difficult for them to find respectable income generation activities upon their retirement. Accordingly, the mental health status of the Army Soldiers in the Post Deployment stage are being affected due to the mentioned above findings.

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# SURVIVAL OF KANDY BEFORE THREE EUROPEAN NATIONS

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**Abstract** - This paper intends to trace the secret of survival of Knadyan kingdom till it fell down to the British in 1815. The innovational methods used by Kandyans since the day Kandy was attacked by Portuguese in later part of 16th century till the British period and more importantly how Kandyans adopted themselves to the novel aspects of gun powder and other military technology of the west would be deeply examined in this research paper. As Prof. Lorna Devaraja pointed out in her most notable paper “Survival of Kandyan Kingdom and its secret “ to Royal Asiatic Society, there were few crucial factors that made impacts on the survival of Kandyan kingdom. This paper examines how traditional knowledge factors and the intrinsic ability of surviving in Kandy with its geography caused to sustain its territory from any debacle. Furthermore this paper will trace the strategic actions laid down by Sinhalese soldiers in Kandyan kingdom against European invaders and how western technology was assimilated into the practice of native military as method of resistance will be questioned in this paper. The historical narratives written by European soldiers during the invasion and other historiographical literature will be used as the research method to carry out this paper work and this paper is based on a doctrinal research methodology to the research question.

**Keywords** - Technology, Warfare, Invasion, Kandy, Military

## I. INTRODUCTION

“Kingdom of Kandy first appeared as a separate entity in Sri Lankan history during the reign of Parakramabahu VI of Kotte Kingdom in Sri Lanka of 15th century A.D” (Dewaraja, 1985, p. 120). Initially kingdom of Kandy happened to be a sanctuary for all the rebels who were

hostile to the rule of low country Sinhalese kingdoms like “Kotte” and “Sitawaka”, but the real strength and its sui generis nature was exposed when Kandy was at bay by the Western invaders (Dewaraja, 1985, p. 120 - 121) (Wickremesekera, 2004, pp. 133,145). In that point resistance against Western invaders who came with renaissance military technology such as gun powder and cannon balls turned into be a Herculean effort, but Kandy could hold its helm till 1815 (Schrikker, 2007, p.15). This paper intends to trace down how Kandy survived against all odds and what reasons strengthened its resistance militarily and strategically. In order to provide a proper analysis this paper discusses the time period of western invaders Portuguese, Dutch separately. Besides the fact of tracing the historiography of Kandyan resistance against Portuguese and Dutch powers this study intends to examine how Kandy was finally subjugated by British in

1815, which finally set the last nail in the coffin of Sinhalese sovereignty in the island (Vimalananda, 1970, p. 30).

## II. KANDYAN AFFAIRS WITH PORTUGUESE

It is not an exaggeration to mention here the resistance envisaged by Portuguese in their Kandyan expedition was the most humiliating experienced by Portuguese in the East. Portuguese historian Fernao de Queyroz in his “The Temporal and Spiritual Conquest of Ceylon” has admitted the resistance shown by Kandyans for Portuguese was an infallible one (Queyroz and Perera, 1992, pp. 55 -66 ). In the question of how Kandy faced a highly developed military forces of Portuguese army, the first pivotal factor to concern is the natural fortification provided the first advantage to the native Kandyan soldiers (Queyroz and Perera, 1992, pp. 60 – 61). It was well known factor that

Portuguese soldiers were militarily always ahead of the natives in terms of the technology and conventional war fares. Though Portuguese soldiers were quite capable of fighting in the plain lands their ability to fight in the hill areas was absolutely limited (Ibid, 61). By nature kingdom of Kandy was protected by its intrinsic natural landscape. The territory of Kandyan kingdom had covered from heavy mountains in its surroundings and it was further strengthened by “river Mahaweli”. In the initial stage of their attempts, Portuguese considered the conquest of Kandy would be a less troublesome task as they conquered the Maritime Provinces in the island but their early military attempts were failed with strong onslaught made by Kandyans in the late 16th century. Battle of Danture in 1594 was the first one Sinhalese recorded a massive victory over Portuguese and in this first encounter Portuguese learnt how nature would be so devastative to them (Perera, 2007, p. 197). In their first campaign in Kandy, Portuguese led a force about 20000 men under Pero Lopez de Souza and 45 elephants more supporting troops from Goa and cannon balls were used in this expedition (Queyroz and Perera, 1992, p. 488). In the beginning of the warfare Portuguese could enter Kandy without much resistance and kandyans strategically abandoned the city without any resources to Portuguese and they burnt the city before they retreated (Wickramasinghe, 2004, p. 16). When Portuguese force took hold of the city their situation became pathetic in the monsoon season with the spread of diseases and raining (Ibid, 154). The natural fortification of Kandyan kingdom did not allow Portuguese reinforcement to reach their troops in Kandy on time; instead of Kandyan resistance force led heavy guerrilla warfare against Portuguese soldiers. This resistance campaign reached its culmination on 8th of October in 1594 in the historical battle in Danturai, where Kandyans could massacre the Portuguese forces which resembles what exactly happened when Napoleon invaded Moscow in 1805 (Perera, 2007, p. 197 - 198). Indeed historian Paul .E. Pieris has argued Portuguese warfare in Kandyan kingdom mainly got unsuccessful due to two main reasons. Firstly Kandy geography was completely a novel experience for Portuguese whereas they had heavy pressure from nature apart from the Guerrilla tactics of Kandyans (Pieris, 1983, pp. 356 - 376). In every invasion they led against Kandyan kingdom they could successfully capture the land in the first round. But the greater debacle befell them in terms of holding the territory for a longer period (Ibid). Every Portuguese captain general tried to surrender the territory from the very first unsuccessful campaign of Pero Lopez de Souza till 1638. In the correspondence made by one of ruthless Portuguese captain generals called Don

Geranimodu Azawedu, he has stated “I carried continuous war into that kingdom, attacking it twice a year with the entire body of troops with the aim of making its life ebb away, by killing off the inhabitants or capturing them by destroying its food supplies and driving the cattle away into our conquered territories So that it is with this regime of war that kingdom is to be bled to death, until it is entirely depopulated and laid waste and in such manner that the life of no male of fourteen years or above is spared” (Goonatilake ,2012, p.5). This carnage went on for decades and the project of annexing Kandy was finally abandoned only after two Captain Generals had lost their heads in the endeavor. Secondly Paul. E. pieris has argued though Portuguese were militarily developed in their weaponry and technology, their military organization in Sri Lanka was a weak one to defeat Kandyans (Perera, 2004, pp. 65 – 66). In that context Portuguese mainly relied on the recruited mercenary soldiers in the low country of Sri Lanka, but when Portuguese reached the Kandyan territory those mercenary soldiers always changed their allegiance to Sinhalese king in Kandy (Perera, 2004, pp. 65 – 66). It became detrimental towards Portuguese war success in Kandyan expedition, because when Portuguese were surrounded by all the troubles in Kandyan territory their mercenary soldiers deserted the army with weapons to join the Sinhalese forces in Kandy (Perera, 2004, pp. 65 – 66).

According to military historian Bruce Vandervort the new weapon technology always became a myth in the colonial warfare (Vandervort 2012). He states “New weapons were slow to arrive on the periphery and when they did, they were often incompatible with the environment in which colonial wars were fought or the kind of warfare being waged” (Vandervort, 2012, p. 92). In the point of matter this theory was applicable to Portuguese experience in Kandy. It is true that Portuguese weapon technology was far advance than Kandyan Sinhalese machinery but that weapon did not fit enough to the geographic conditions of the Kandyan territory. In the chronicles of Rebeiro (Portuguese army commander) it has been reported when the heavy rain hit Kandy those gun power and canons got ineffective to work in the battle field (Ribeiro and Pieris, 1999, p. 20). On the other hand Kandyans were witty enough to assimilate the western military technology into their resistance. As an example first Sinhalese king who could defeat Portuguese was Vimaladharmasuriya I I was earlier trained by Portuguese in Goa and finally he deserted the Portuguese after acquiring sufficient military knowledge and formed the resistance front against Portuguese (Pieris, 1983, pp. 334 -355). On the other hand



the successors of Vimaladharmasuriya I I started to adopt and imitate Western military technology in certain ways (Wickremesekera, 2004, p. 145). Robert Knox who was a prisoner of Rajasinha II had reported how Sinhalese king in Kandy kept Scottish mercenary gunmen and encouraged those Europeans to marry native women in order to keep them in his service (Bakel et al. 1994, p. 197). Apart from that Kandyans always maximally utilized the local knowledge against the gigantic European military tactics (Silva 2011). In some occasions those captured canons and guns were remanufactured by Sinhalese craftsmen in their own standards (Wickremesekera, 2004, p. 145). In the case of weapon technology Kandyans aptly understood the effectiveness of improvising their own arms and immunes in par with Portuguese. The historical references made by Portuguese historians like Queyroz and Ribeiro have affirmed how effective when Sinhalese soldiers used short swords against the conventional fencing technics of Portuguese (Ribeiro and Pieris, 1999) (Queyroz and Perera, 1992).

A modern historian who has extensively written about Kandy's wars with Portuguese Dr. Tikiri Abeyasinghe has commented in his book "Study of Portuguese regiments on Sri Lanka at Goa archives" (Goonatilake, 2012, p. 3 - 7). For four decades the Portuguese desire to annex Kandy had been nearly counterbalanced by Kandy's will to survive, and the Portuguese capacity to strike by Kandy's ability to resist. On every occasion the Portuguese attempted to tilt the scales in their favour, in 1602-1630 or 1638 - they had failed" (Dewaraja, 1985, pp 121 - 122). In modern understanding of a mind of a historian or an International Relations theorist one can simply say that this situation was akin to what described by historian Arnold Toynbee as "stimulus of blows" (Dewaraja, 1985, p. 122). In Toynbee's interpretation blow," there are sensational instances in history where military power had been stimulated by successive contests with neighbours. Kandy did not respond by being aggressively militaristic, but the heaviness of the blow evoked in the Kandyans a proportionately powerful psychological reaction, an abhorrence of foreign rule, a characteristic which they displayed on several occasions till all resistance was clamped down by the British in 1818" (Dewaraja, 1985, p. 122)

Another important fact regarding the new knowledge built by Kandyans in their extraordinary resistance before British was the way Kandyan kings maintained their geographic position without letting it to be spoiled by the novelties of time. As an example Kandyan kings

had a deliberate policy of discouraging building roads and bridges which finally became the savior of Kandyan kingdom for a long period. In the historical annals of Sri Lanka the kingdoms which existed before Kandy had more sophistication in terms of infrastructure facilities within the main city. For instance today's ruins and monuments of "Anuradhapura" and "Polonnaruwa" are the evidence that demonstrate how Sinhalese kingdoms had been in its heyday. But under 300 years of constant struggle against Portuguese, Dutch and English, Kandy did not have the full pledge pleasure of nourishing herself as a conventional kingdom. Instead of it turned into be a bastion of natural fortification surrounded by untouched forests and those adoption were willingly accepted and adhered by her people. Dr. Lona Devaraja ( Sri Lankan historian who had specialized in Kandyan history ) states "It has often been said that the inaccessibility of the mountain kingdom, the ravines, swamps and rivers, the malarial mosquitoes and the blood sucking leeches that proved vicious under European armour had preserved Kandyan independence" (Dewaraja, 1985, p. 123). It was a "deliberate policy of the Kings to discourage the building of roads and bridges and the clearing of forests so as to make the kingdom even more unapproachable to intruders" (Ibid). In fact most of the nations in Africa and Asia had used the tactics that would stun the European invader. There are many examples such as how mighty British army of Lord Chelmsford was annihilated by Zulu tribe of Africa in battle of Isandlwana in 1877, where Zulu's favorite tactic was the izimpondo zankomo ("horns of the buffalo"), where the older warriors of the Zulu force engaged the enemy from the front while the younger warriors circled around both flanks and attacked (Peck 2014). In the context of Kandyan kingdom Kandyans firstly attacked the good carriages, animals and local coolies of the invader with the intention of cutting down the supply to the enemy. In most of the time their tactic was successful when Portuguese forces were left without food and other essential supplies.

#### **A. Dutch Era**

Kandy's strategic position with Dutch was shaped by different events and it was mainly culled by the diplomatic negotiations between Sinhalese king in Kandy and Dutch in Colombo. On the other hand it was Dutch who benevolently appeared to assist the Kandyan king Rajasighe II to expel Portuguese from the Maritime Provinces when Kandy was in the doldrums after fighting for 40 years with Portuguese (Codrington, 1994, pp. 133 -135). In the relationship with Dutch, both the parties hardly went for fight with each other except the fact that

Kandy was attacked by Dutch in 1766 during the time of King Kirti Sri Rajasinha. But Dutch never had the true need to gain the control of whole Kandyan kingdom, because unlike ambitious Portuguese who believed they were on holy quest to convert pagans into Christianity, Dutch interests were mainly confined to the commerce and trade (Codrington, 1994, 133 -155).

### **B. How British finally nailed Kandy**

As it was stated in the beginning, another important motive of this paper is to analysis how Kandy reached its end by the last and deadliest attack from the British which was mightier and more strategic from both previous invaders (Sivasundaram, 2007, p). It was in 1796 British conquered the whole maritime provinces of Ceylon from Dutch and the rule of English East India Company continued till Maritime Provinces became a crown colony of the British Empire in 1802 (Wickremeratne, 1973, pp. 31 -33). As a matter of fact it is an interesting factor to examine how kandyan kingdom confronted by British forces. In an article written by Cambridge based historian Sujit Sivasundaram , author argues the topographic knowledge of Kandyans helped them to survive before British for few years but British too went for reverse engineering when they developed the skills of the Kandyan warfare and their technology in certain ways (Sivasundaram, 2007, p. 925). As an example after taming the last Kandyan resistance for British in 1818 in most brutal way British immediately built up a new road system to Kandy from Colombo and went on to cut down the surrounding forests which provided a natural canopy for Guerrilla war fares of the Kandyans (Sivasundaram, 2007, pp. 926 -931). But it important fact to remember even before Kandy fell into British hands, the first military expedition led by British in 1803 under the leadership of Gen. McDowell became a catastrophe for British mainly due their lack of awareness of the geography of Kandyan kingdom and the interesting factor is the same method used by Kandyan kings against Portuguese in 17th century lasted till 18th century Kandyans to resist for British attacks (Wickremeratne, 1973, pp. 38 -41). It is not the fact that Kandyans were the most brilliant soldiers in the world, but what made them unique was their adaptation of geographic spaces and guerrilla military strategies in action. In 1803, when British waged war with Kandyans, the lack of accurate maps proved perilous. Major Arthur Johnston of the Third Ceylon Regiment has described how those dark forests and abrupt attacks of Kandyan forces in the wilderness of Kandyan terrain (Sivasundaram, 2007, pp. 932). He states "In these thick forests, even in the

brightest moon -light it is extremely difficult, and often impossible, for one not perfectly acquainted with the track to discern the footpath" (Ibid). In the cause of military technology Kandy had developed and duly adopted the Western technology by the time British intervened its territory. Kandyan kingdom's army was a palpable reflection of a pre modern Asian army and in fact a large standing army was not feasible due to the lack of money. Instead of keeping a regular force Kandy maintained voluntary force which was consisted of peasantry while having a small number of foreign troops as a permanent army. In the case of weapon technology Kandyans had the gun powder technology and according to Robert Knox's narratives there were European residents in Kandyan kingdom who operated the guns (Wickremesekera, 2004, pp. 141,145). Apart from that Kandy's own invention called "Kodithuwakuwa" played a crucial role as fire weapon against the British (Wickremesekera, 2004, p. 145). Indeed it was an indigenous product and became an ideal substitute for artillery (Ibid). The officers who were in charge of "Kodituwakku" were known as "koddituwakku karayao"(Ibid, 141). This weapon as an indigenous product proves how those western military technologies had been absorbed by Kandyans in an innovative way in the process of resistance.

However in evaluating the reasons to the decline of Kandy as the last sovereign kingdom in Sri Lanka, one should understand Kandyan kingdom's decay and its subjugation to British in 1815 was not a result that came out of the blue. Yet its roots had traced back to the middle of 18th century in that period kandy was in a greater dilemma when her last Sinhalese king Sri Vira Parakrama Narendra Sinha died childless in 1739, which created a vacuum in the throne. Finally this led to create a new dynasty in Kandy and those rulers hailed from South Indian Nayakkar dynasty which crated a heavy unrest among the Kandyan Sinhalese nobles (Dewaraja, 1985, p.127). They were Tamil speaking; Hindus and this further agitated the Buddhist monks in the Kandyan kingdom. In the analysis given by Dr. Lorna Devaraja, Buddhist monks in Kandy were typical land lords in Weberian sense and their opposition towards Tamil speaking knew rulers became a strong factor to lose the grip of Kandyan kingdom (Ibid). In addition to that, British too had adhered to the traditional warfare and as a practical method of defeating the Guerrilla tactics of Kandyan hill country; they used experienced soldiers on mountain warfare. As an example when 1815 Britain successfully captured Kandyan kingdom with the fullest support of Sinhalese nobles, most of the British soldiers happened to be soldiers from Ireland or some Scottish

regiments of British army and those soldiers were trained to fight in mountain campaigns (Bakel et al. 1994, p. 198) (Dewaraja, 1985, p.133). Another tactful method used by British on subduing the resistance of Kandy was using espionage through low country Muslims. It was a master minded plan by Oxford educated British officer John Doyly (Senaratne, 2013).

He was a bureaucrat like William Jonnes in India, a person who was deeply infatuated with the local customs. Being a Latin and Greek scholar from Oxford Doyle felt passionate to learn Sinhalese and oriental languages like Pail, Sanskrit (Ibid). His approach to manipulate Kandyan chieftains against the last king accelerated the decay of Kandy. In fact Doyly's spies could infiltrate into the terrain of Kandy as merchants and gathered valuable information. With these circumstances Kandy could resist for no more and ultimately nailed by British in 1815 with the full pledge support of Kandyan Sinhalese nobles under the impression that they would be given the rightful throne to govern themselves. But it only became a fallacy and three hundred years of constant existence despite all those mighty attacks of the Western nations reached its bottom end before the realistic plans of British both militarily and strategically.

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### III. CONCLUSION

This paper has discussed the routines of kandyan resistance till it fell unto British hands, furthermore the military strategy, local knowledge and above all how geographic position became a paramount factor in deciding the fate of a war has been depicted in this study. Kandy's survival and its down fall have laid down certain lessons to the military affairs in several ways. Firstly it has proven a wrong perception on colonial wars as a one sided battle which always crushed the natives. But Kandyan experience proves the story had gone the other way around since Kandyan kings and soldiers duly adopted the military technology and tactics according to their needs. Many of the illustrations have been provided in this paper to prove it. Secondly Kandy rebuts another myth of superiority of weapon technology of Europeans. The examples given in this paper show how those mighty weapons became futile when westerners were encircled by guerrilla warfare and

unconquerable forces of nature. This has been accepted by war historian Bruce Vandervort in by quoting a British colonel called Charles Callwell. He states "in most of the colonial wars real foes were climate, disease and distance, lack of food and water" (Vandervort , 2012, p. 71). Indeed this example was well manifested on the soil of Kandy. Thirdly kandyan resistance and its survival prove the gravity of an unconventional warfare could be detrimental upon any powerful nation. What exactly took place in Kandyan kingdom against western forces has not gained the attraction of war historians and scholars. Especially the knowledge possessed by Kandyans and their unique resistance to three mighty western nations should be well researched.

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# ENTREPRENEURIAL ASPIRATIONS AND EXPECTATIONS OF SRI LANKA MILITARY VETERANS

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**Abstract** - In Sri Lanka Army, there are soldiers retiring in the active age group of 40-45 and most of them are with lots of experience, skills, knowledge and potentials which could be utilized to enhance the country's economy whilst providing them with meaningful employment opportunities or converting them as successful entrepreneurs. However, there is no realistic and scientifically drawn up mechanism in Sri Lanka to properly absorb them into the active labour force with maximum utilization. In this backdrop, their skills, knowledge and potentials will be underutilized and it will be a loss for the country's economy in the long-run.

Unlike in developed countries, in Sri Lanka, this issue of veterans' transition into successful civilian life has not yet been addressed by both researchers and policy makers. Moreover, many researches undertaken by defence establishments rarely come into public domain. This paper examines the entrepreneurial aspirations and the expectations of retired military personnel of the Sri Lanka Army in successful transition from military life to civilian life and preparing them for entrepreneurship as a post military career choice.

**Keywords** - Aspirations, Expectations, Transition, Entrepreneurship, Post Military Career

## I. BACKGROUND OF THE STUDY

Sri Lanka Army being the oldest and largest of the Sri

Lankan armed forces is comprised of Regular Force, Regular Reserve, Volunteer Force and Volunteer Reserve responsible primarily for military and humanitarian operations in the country. In addition, the Sri Lanka Army has also responded to disasters and emergency situations such as natural disasters (e.g. Tsunami, Landslides, floods and forest fire) and resettlement of Internally Displaced People (IDP).

According to Directorate of Pay and Records of the Sri Lanka Army, by the end of 2016, approximately 9,500 officers and 180,000 other rankers (Directorate of Pay &

Records of the Sri Lanka Army) were on active service. Other rankers of Regular Force retire upon completion of 22 years in the case of men and 15 years in the case of women whilst Volunteer Force other rankers can serve till 55 years of age. Options are available for soldiers to retire once they complete 5 or 12 years of service as well, but such retirees are not entitled for pension, except those who are medically categorised within 12 years of service.

It is mandatory that all other rankers undergo basic military training for 4 to 6 months and while on active service, they go through various combat and non-combat training courses both locally and abroad that are designed to develop their skills and knowledge. On average, a soldier receives a total of 2 years of training during the 22 year service in the Army. As per the records of Directorate of Pay & Record of the Army, approximately 4 percent

of the service personnel of average age between 40 to 45 years retire from service annually. From 2010 to 2015, approximately 25,000 soldiers have retired. A majority of the other rankers leave the Army after 22 years of service are still in productive age with considerable experience and skills (Directorate of Pay & Records of the Sri Lanka Army). Average age of retiring soldier is 40 years. However, many of these capable and dedicated veterans have less or no opportunities to use their skills and experience and become economically successful people. They leave civilian life and make a transition to the community of the military while being trained in its ways and follow its culture. However, when servicemen or servicewomen leave the armed forces for varied reasons, they necessarily make a transition back to civilian life and this can be challenging for veterans.

It is important to note that a vast majority of these soldiers are employable as they retire with lots of experience, skills and knowledge that can be easily transferable to civilian careers. Although, there are no reliable statistics on post retirement employment of veterans, formal and informal data available with respective regiments suggest that a vast majority of them engage in some form of a waged or self-employment. However, there is a widely held notion that retired soldiers are ill prepared for the retirement life and thus end up in jobs that do not fit with their skills and experience. The security sector is the hope for many retired soldiers while some end up in transport sector. It is pretty obvious that there should be a mechanism to identify this target group and implement an appropriate intervention to encourage them to engage in self or paid employment so that they can become successful economic actors. If such a system exists, these personnel can easily integrate into the labour market and thus contribute to the economy in an effective way.

Returning to civilian life presents new opportunities and challenges for Veterans. Many veterans look forward to life after the military because they can spend more time with family and friends and they no longer have to worry about military structure or deployment. At the same time, transitioning out of the military may raise a lot of questions.

They may wonder what they are going to do with this new phase of their lives or whether they will be able to find suitable jobs. They may think about going back to school but do not know where to start; or they may miss the order and discipline of military life compared with civilian life and wonder if they will be able to adjust.

## II. LITERATURE REVIEW

The expected post military retirement life of veterans was not clear. It may be positive or perhaps negative; or else may be successful and discontinuous (Mongia, 2013). However, as McDermott (2007) indicates, the effects of military service for the majority of those who have completed a full military career can be both positive and beneficial. The Army veterans generally maintain a disciplined approach to life and a strong work ethic. Most will reject any notion that they are not fully 'civilized'. It is clear that full disengagement from military society is only ever partially achieved. The veteran remains different in the way that he or she associates with others in civilian society. Whilst then young soldiers become old soldiers, their return and adjustment to becoming civilians are never complete (McDermott, 2007).

As London and Wilmoth (2012) indicate the consequences of transitioning to civilian life during the period will vary across many factors. Some are heterogeneity among veterans, economic pressures, veteran's socio-economic problems etc. In case of heterogeneity among recently transitioning veterans, their experiences over time by examining how employment, school enrollment, earnings and poverty vary in the pre-recession and post-recession periods by sex, age, race/ethnicity, citizenship and status. Furthermore, educational attainment, marital status, disability status, non-metropolitan residence and region etc. have made a tremendous effect (Furstenberg et al., 2010). Settersten and Ray (2010) indicate that veteran status and heterogeneity among veterans affect the initial transition from military to civilian adulthood. It is during a period of war, economic recession and substantial change in the norms surrounding the transition to adulthood. Settersten and Ray (2010) concern, how the economic pressures influence on post military employment applies to males and females are different. The study affirms that the economic pressures reduce the post-military employment is greater for male veterans than for female veterans. The main reason for such deviation makes due to male and female motivation; internal motivation and external motivation. A person's internal motivation is one of the biggest factors that makes an impact towards results of employability (Smaliukenė, 2014). Further, taking a classical approach towards boundary fewer careers, the retired officers have to take responsibility for their own future career. However, Dandeker et al (2003) is in different opinion as they are not being able to settle in civilian life. Further, he states after becoming socialized (or institutionalized) into the highly structured,

disciplined and somewhat sheltered life of the military. They are motivated into employment.

The study done by McDermott (2007), accepts that some ex service personnel do experience difficulty in civilian society. When examines closely the notion that the majority of those leaving the armed forces 'do well' as civilians. Further, it is generally held in the literature that some ex-service men and women suffer as a result of their military service. The greater majorities do not and leave the armed forces to lead successful civilian lives. However, it is among this sector of the ex-service population that veterans who have been successful in civilian life can be found (McDermott, 2007). This problem cannot be left alone, as such; need an acceptable solution. Different authors who are interested in, proposed different strategies based on different career factors and non-career factors. As proposed by McDermott (2007), such factors do exist and military service provides positively for a successful transition to civilian life. Military provides veterans with a satisfying career with recognized qualifications. It also provides a set of high moral values and high work ethic, a positive self-image and positive attitudes to health and diet. Therefore, they need to be well prepared before they were discharged (McDermott, 2007). Numerous problems arise in their mind even after several years of life as civilians. Several of the veterans indicate to differences. They still feel between those like themselves who have experienced military service and those who have not McDermott (2007). Further the factors such as disengagement, total denial or total forgetting or turning their backs on their military past have not been seen well (McDermott, 2007).

Smulders and Jagoda (2011) in their research on military entrepreneurship in Canada have highlighted that the stress of adjusting to civilian life and choosing a new career were priorities for most of those retired from Armed Services. It has also been highlighted that providing opportunity for veterans to use their leadership, organization and team building skills allow them to determine their own course of action for re-entering workforce.

According to Morin (2011) practicing military service is more difficult, demanding and dangerous. Similarly returning to civilian life also will be difficult where military veterans who were commissioned officers and graduated from colleges are more likely to readjust to civil life than high school graduates (Morin, 2011). The analysis has found that exposure to emotionally traumatic events and serious injuries are common in the military and those who experience the same find it difficult to re-enter the

civilian life. Angulo (2015) states many soldiers do not start planning for civilian life until close to their date of retirement or separation. "Meaningful employment/entrepreneur in the civilian world enables our soldiers, veterans and their families to remain strong even after transition and to serve as leaders and as contributing members of their communities". Veterans present a significant subject for study in their own right and were of great interest because they constituted a substantial segment of the national labour force.

#### A. Objective of the Study

The objective of this paper is to explore and analyse the entrepreneurial aspirations and the expectations of retired military personnel of the Sri Lanka Army in successful transition from military life to civilian life and preparing them for entrepreneurship as a post military career choice.

### III.METHODOLOGY OF THE STUDY

As the study is with an observable reality, its results can be generalized. This is similar to those produced by other studies. Therefore, this study is based on positivism by research philosophy. As the study aims to work objectively, with little or no personal interpretation of the data, a structured methodology is used to gain quantitative data. These data are replicable and can be analyzed using relevant statistical methods. Overall, this process was aimed to treat this study as a study in positivism.

In this paper aspirations and expectations of the veterans have been examined. They are analyses using qualitative empirical case studies method. For primary data collection, disproportionate stratified random sampling method was used for selection of survey respondents. Disproportionate sampling decisions are made either when some stratum or strata are too small or too large, or when there is more variability suspected within a particular stratum (Sekaran and Bougie, 2014). Sample element of the study is the soldiers. Sampling population is 1300 and sampling number is 520 which consist of veterans retired between 2014-2016. The sampling procedure is done in a systematic way as shown in the following briefings.

Sample size approximately represents following population where sampling frame is based on retired veterans. The Sri Lanka Army comprised of 24 Regiments of which the

entire population belong to. There are four different types of regiments; fighting, combat support, combat service support, and fighting & clerical. There are nine fighting regiments in the Army representing the largest segment of the total population and their roles and tasks are similar in nature. Although, they represent the largest segment of the total population, only 300 numbers were selected as samples, because their roles and tasks are similar in nature and 300 numbers are adequate to represent the total fighting population. Out of 300 samples selected, they will represent 100 each from three different fighting regiments, mainly to avoid geographical influences and possible biasness towards the researcher as the researcher too is representing a fighting regiment.

There are five combat support regiments and their roles and tasks are not similar. Therefore, 250 numbers (50 from each combat support regiments) were selected as samples and they can effectively represent all combat support regiments.

There are nine service support regiments and their roles and tasks are not similar. As they perform different roles and tasks, one or two regiments cannot represent the nine service support regiments. Therefore, 75 samples from each regiment were selected making a total of 675 numbers to represent the service support regiments enabling to obtain more valuable and differentiated information with respect to each group.

There is only one Women Corps regiment in the Army and the population comprised of female. Therefore, 75 samples were selected to represent female and it will adequately represent the female population. However, the element of the sample is veterans while sample unit is the Army veterans. Sampling frame was taken from the information available in the Ministry of Defence. For the quantitative data analysis, semi-structured questionnaire method is widely used. The questionnaire comprises of the components of Post Military Career Choice, Aspirations, Expectations of Retiring Veterans, Capabilities, Potentials, Motivational and Non-Motivational Factors, Career Opportunities, Entrepreneurial Possibilities, Economic Development, Post Military Life, Bottlenecks, Capabilities and Personal Details.

Case studies method is used for the qualitative data analysis. An attempt is made to explain aspirations and expectations of the veterans qualitatively in this paper. For quantitative data analysis and representation, Microsoft

Excel 2007 was used. It was used to analyze the descriptive statistics and the reliability of this study.

**B. Results of the Study**

**• Survey Data**

The Table 1 illustrates the gender of the veterans in the study sample of 533 veterans.

**Table 1: Gender Comparison**

Gender	Frequency	Percent
Female	42	7.9
Male	491	92.1
<b>Total</b>	<b>533</b>	<b>100.0</b>

*Source: Survey Data (2016)*

As per the Table, 491 were male and 42 were female whose percentages are 92.1 percent and 7.9 percent respectively. The military organization of the country is formed with the composition of majority of male members. Female soldiers in the Army will have to serve a minimum of 15 years of military service to entitle pension benefits enjoyed by the male counterpart who completes 22 years in the Army.

The above mentioned military veterans tend to do a second career due to their economic hardships. Table 2 depicts their responses:

**Table 2: Economic Hardships lead to Post Military (Retirement Employment**

	Frequency	Percent
Strongly Agree	200	37.5
Agree	116	21.8
Neutral	148	27.8
Disagree	51	9.6
Strongly Disagree	18	3.4
<b>Total</b>	<b>533</b>	<b>100.0</b>

*Source: Survey Data (2016)*

Majority of veterans being 316 (59.3 percentage) agrees that they need a second career due to the pension income is not adequate and a considerable amount being 27.8



percentage remain neutral. Only 13 percent disagree and indicates that they need a second career not due to economic hardships. However, it could be the reason for a balanced retired life as indicated in Table 3.

**Table 3: Employment for Balanced Life**

	Frequency	Percent
Strongly Agree	162	30.4
Agree	160	30.0
Neutral	114	21.4
Disagree	58	10.9
Strongly Disagree	39	7.3
<b>Total</b>	<b>533</b>	<b>100.0</b>

*Source: Survey Data (2016)*

The veterans who aspire a balanced retired life make up 322 and its percentage is 60.4 percent. However, 114 remain neutral and the percentage of the neutral responses makes 21.4 percent. Military veterans, who have not been leading a satisfactory life due to their non-fulfillment of career expectations while being in the military, attempt to seek possible ways to fulfill their aspirations in the prospective second career. Table 4 shows their responses:

**Table 4: Seeking Ways for Fulfilment of Aspirations**

	Frequency	Percent
Strongly Agree	126	23.6
Agree	177	33.2
Neutral	95	17.8
Disagree	77	14.4
Strongly Disagree	58	10.9
<b>Total</b>	<b>533</b>	<b>100.0</b>

*Source: Survey Data (2016)*

Out of the veterans of 533 study sample, 303 agree that they seek avenues to fulfill their career expectations in the probable second career. It represents 56.8 percent from which 23.6 percentage of veterans strongly agree (126 veterans). 17.8 percent remains neutral. Only 25.3 percent disagrees the statement. Therefore, it is viewed that the opportunity of the second career of the military veterans to be facilitated to realize their unfulfilled aspirations in life.

	Frequency	Percent
Strongly Agree	200	37.5
Agree	116	21.8
Neutral	148	27.8
Disagree	51	9.6
Strongly Disagree	18	3.4
<b>Total</b>	<b>533</b>	<b>100.0</b>

Furthermore, Due to the fact that the majority of veterans need to fulfil aspirations of their family members, they opted for a second career. The responses of veterans who tend to engage in a second career due to fulfilment of family expectations are depicted in the Table 5.

**Table 5: Fulfilment of Family Expectations**

	Frequency	Percent
Strongly Agree	121	22.7
Agree	111	20.8
Neutral	192	36.0
Disagree	68	12.8
Strongly Disagree	41	7.7
<b>Total</b>	<b>533</b>	<b>100.0</b>

*Source: Survey Data (2016)*

As per the Table, majority of veterans being 232 (43.5 percent) agrees that they need a second career due to family expectations and a considerable amount being 36 percentage remain neutral. Only 20.5 percent disagrees the statement. As well, the duty fulfilments upon retirement prompt a section of veterans to engage in second career.

**Table 6: Duty Fulfilment upon Retirement**

	Frequency	Percent
Strongly Agree	239	44.8
Agree	172	32.3
Neutral	77	14.4
Disagree	30	5.6
Strongly Disagree	15	2.8
<b>Total</b>	<b>533</b>	<b>100.0</b>

*Source: Survey Data (2016)*

As per the table 6, veterans numbering 411 representing 77.1 percent have agreed on duty fulfilment upon

retirement. 77 veterans which is 14.4 percent remain neutral whereas only 45 veterans which represent 8.4 percent disagree the above statement. However, veterans in the study sample are in a view that they enable to fulfil the aspirations of their children would in their second career. Responses of the veterans who hold such stances are depicted in the table 7.

**Table 7: My Possibility in Fulfilment of Children’s Aspirations**

	<b>Frequency</b>	<b>Percent</b>
Strongly Agree	202	37.9
Agree	192	36.0
Neutral	107	20.1
Disagree	23	4.3
Strongly Disagree	9	1.7
<b>Total</b>	<b>533</b>	<b>100.0</b>

*Source: Survey Data (2016)*

According to the Table 7, there were 394 veterans who agreed that they would fulfill the aspirations of their children during their retirement. Its percentage is 73.9 percent. However, the table illustrates that 32 veterans being disagree indicating a total of 6 percent is yet to fulfill aspiration of their children. Yet, the response of 107 veterans (20.1 percent) which is a considerable number who remains neutral has to be addressed. Conversely, veterans who retire the Army possess various expectations to be fulfilled during the retirement as illustrated in the following tables.

**Table 8: Adequate Military Experience to Fulfil Social Expectations**

	<b>Frequency</b>	<b>Percent</b>
Strongly Agree	250	46.9
Agree	202	37.9
Neutral	49	9.2
Disagree	23	4.3
Strongly Disagree	9	1.7
<b>Total</b>	<b>533</b>	<b>100.0</b>

*Source: Survey Data (2016)*

As per the responses in the Table 8, the majority of the veterans being 84.8 percent shows agreement that they

possess adequate military experience to fulfil social expectations. Consequently, only six percent being 32 veterans do not agree that they possess adequate military experience to fulfil social expectations whereas 49 veterans (9.2 percent) remain neutral.

The study focused on whether the veterans receive adequate pension to fulfil family or personal economic expectations as show by Table 9.

**Table 9: Adequate Pension to Fulfil Family/ Personal Economic Expectations**

	<b>Frequency</b>	<b>Percent</b>
Strongly Agree	19	3.6
Agree	28	5.3
Neutral	139	26.1
Disagree	162	30.4
Strongly Disagree	185	34.7
<b>Total</b>	<b>533</b>	<b>100.0</b>

*Source: Survey Data (2016)*

A striking feature of the majority of the veterans is their disagreement to the statement of adequate pension to fulfil economic expectations. The number of such veterans is 347 and its percentage is 65.1 percent. Only 8.9 percent agrees and 26.1 percent remain neutral.

However, the Table 10 below shows that the veterans need an additional income. 419 veterans, the percentage of which is 78.6 maintained that they have dire need of extra income. Hence, they tend to engage in a second career.

**Table 10: Dire Need of Extra Income**

	<b>Frequency</b>	<b>Percent</b>
Strongly Agree	260	48.8
Agree	159	29.8
Neutral	77	14.4
Disagree	23	4.3
Strongly Disagree	14	2.6
<b>Total</b>	<b>533</b>	<b>100.0</b>

*Source: Survey Data (2016)*

According to the findings as depicted in the tables above, the military veterans who are retiring from the military have a strong requirement of having a second career which allows them to fulfill the post-military career expectations

while earning an extra income that enables them to achieve financial security and achieve better life.

#### • Case Study

The veteran of this case is a Warrant Officer Class One of Sri Lanka Army National Guard. He had served the Army for 22 years and upon retirement he has started hardware trading shop business investing Rs. 300,000.00 from his savings. He gradually developed it and presently there are six employees serving under him. During his military career, he had set a few goals to be achieved before his retirement. He had his school education up to G.C.E. (O/L) examination and wanted to study more. However, as a son of a rural farming family, he had to give up his studies because of economic difficulties of his family. Therefore, he joined the Army. After the basic military training, he was posted to a fighting unit and took part in military operations. Although, he had wanted to follow vocational training course, his Commanding Officer had rejected his application due to his engagement in military operations. Meantime, he could not save much as he had to allocate some money to redeem the ancestral home which had been mortgaged prior to his sister's marriage. His aim was to repair and re-modify the house. He was able to reconstruct a part of the house but failed to complete the repair. After his marriage and his family become large with three children, house construction work totally paralysed due to increasing family financial commitments.

When he retired from the Army after 22 years of service at his age of 40 years, he had unfulfilled aspirations and expectations. His children were schooling and needs a lot of money to fulfil such aspirations and expectations of his wife and children on their higher studies, marriages a family vehicle etc. His pension was inadequate and he thought that mere employment would not help him to overcome his problems.

The total savings at the retirement was only Rs. 1.5 million. So he decided to utilize Rs. 300,000.00 to start the business. He worked hard, his wife and her brothers supported to develop it and saw a gradual improvement in his business. During five years of his business, he could gradually restart his partially constructed house while paying attention to his children's education. This case study illustrates that veterans struggle to fulfil their military and civil life expectations and aspirations. He was not able to continue his school education due to economic hardships that is very common in the agricultural families in rural sector. This is one of the reasons rural youths to join the

Army and trying to achieve life aspirations. The veteran aspired a better life, develop his vocational training knowledge base, and construct a new house and have a better life. During his military life spanning 22 years he failed to completely fulfil his aspirations and expectations. Yet, he had obtained a good training for his life, expertise knowledge and experience whilst being in the Army. Such have been a valuable resource for him which is useful even after his retirement.

Having explored various avenues to fulfil his unfulfilled aspirations, he decided to invest a portion of his savings to start a business and saw possibility to expand his business with the support of his family. Since he enabled to successfully apply the resources that he collected from the Army, he gradually developed his entrepreneurial activity achieving his goals and gradually fulfilling his aspirations and expectations of his loved ones.

This case study shows that success of the post military career is mainly due to the training and other attributes gained during his military service. They are of highly influential in the military veteran's transitioning from the military career into successful entrepreneur. As per the results of the study, it has been revealed that the majority of the retired military veterans aspire to fulfil the expectations that had not been achieved during their military life. Table 7 depicts that majority aspires to fulfil aspirations of their children while Table 9 depicts a strong requirement to fulfil economic expectations of the veteran. Therefore, they wish to engage in a secondary career to fulfil the aspirations of the veteran as well as their family members. In addition, they wish to achieve family expectations and societal expectations.

The case that briefly explained above as well indicates that he had unfulfilled aspirations and expectations during the military career due to his inadequate financial capital. He had his worries with respect to construction of his house, children's education, their marriage as well as a family car etc. Therefore, he aspired to achieve his unfulfilled aspirations and expectations in the potential entrepreneurial activity upon retirement. He succeeded in them successfully upon his retirement with his engaging in an entrepreneurial activity and achieve the aim of a better life for his family. The main focus in this paper is the post military career choice of veterans who retire from the military after serving in the military for 22 years. During the long years, they enable to accumulate an array of experience, knowledge and entrepreneurial skills and qualities which are highly resourceful in their second

career. It further discusses on how they perceive their post military life and how they want to spend their post retirement life.

Under normal circumstances, majority of the service personnel have young families and their commitment and responsibilities towards the families are challenging for them. Accordingly, the decisions of the veteran at their post military lives are mostly dependent on family responsibilities and financial stability. It is a fact that the personnel who join the Army at their prime youth serve the Army and the average age at their retirement is 40 years.

The vigorous active and healthy military life of the veteran permits them to restart a post military career which primarily serves them both with additional income and fulfillment of diverse career expectations. In the survey conducted using the retiring veterans, the respondents were asked to indicate the selection of their post military career. The analysis described in the section under results of the study in this paper reveals that the majority of the veterans prefer to engage in a second career mainly due to one or more of the reasons of economic nature, fulfillment of their aspirations and expectations of the retiring veterans.

**IV.CONCLUSION**

This paper deals with entrepreneurial aspirations and expectations of Sri Lanka military veterans. One of the main aspirations is fulfilment of personal and children’s aspirations. Further, they aspire to fulfil family as well as societal expectations while they expect to overcome economic hardships as the pension income does not adequately facilitate to overcome their economic hardship. Therefore, they expect a second career to fulfil the post-military career expectations and to achieve financial security for improved living.

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# RE-EMERGENCE OF TAMIL TIGER CELLS IN SRI LANKA: A COMPARATIVE ANALYSIS TO TERRORISM PERSPECTIVE

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**Abstract** - Ethnic conflict had created political, economic, and security influences in Sri Lanka. From the late 1970s until 2009, the Liberation Tigers of Tamil Eelam known as LTTE conducted a massive violent campaign against the government of Sri Lanka due to decades of political disparity and the policies of central government, political and economic disparity and repression. Brutal terrorist struggle expanded over 30 years, which made the country a war zone due to suicide bombings and other deadly attacks. In 2006, the Sri Lankan military launched a major offensive against the LTTE, bringing the entire country under their control and defeating the LTTE militarily. However, it is indicated that there could be a possible re-emergence of the LTTE cells in Sri Lanka. This study identifies causes and effects of re-emergence of the LTTE cells in Sri Lanka and how does terrorism re-emergence as cells, a comparative analysis of terrorism perspectives. Further, an analysis of these perspectives demonstrates that due to long standing unsolved socio-economic and political issues augmented with external factors such as Tamil diaspora and Indian Tamil Nadu influence, could contribute to re-emergence of LTTE cells in Sri Lanka. The author will adopt mix method to gather data relevant to the subject matter.

**Keywords** - LTTE cells, re-emergence, repression, socio-economic, brutal

## I. INTRODUCTION

Ethnic conflict of Sri Lanka is a well-known issue in the international forum. From the late 1970s until 2009, the Liberation Tigers of Tamil Eelam known as LTTE conducted a massive violent campaign against the government of Sri Lanka due to decades of political and economic disparity, the policies of central government,

and repression. Brutal terrorist struggle expanded over 30 years, which made the country a war zone due to suicide bombings and other deadly attacks. Since 1983, 80,000 to 100,000 people including Tamil, Sinhalese and Muslim civilians have been killed due to the ethnic conflict. In 2006, the Sri Lankan military launched a major offensive against the LTTE, bringing the entire country under their control and defeating the LTTE militarily. However, intelligence reports reviewed indicate that there could be re-emergence of the LTTE cells in Sri Lanka. But, how does the LTTE re-emerge after three decades of deadly war to fight for a separate state? Therefore, this paper will argue that due to long standing unsolved socio-economic and politics issues augmented with external factors such as Tamil diaspora and Indian Tamil Nadu influence could contribute to re-emergence of LTTE cells in Sri Lanka. As such, this scholarly paper unfolds as follows: part one: historical background to the conflict; part two, causes and effects of the re-emergence of the LTTE and part three, how does terrorism re-emerge as cells, comparative analysis of terrorism perspectives and finally, findings and conclusion.

The research method used for this study is “qualitative analysis method” based on primary data. The research objectives are to identify; one, will there be any re-emergence of LTTE cells in Sri Lanka in the post conflict scenario; two, the contributing factors for re-emergence of LTTE cells in Sri Lanka; three, identify factors contributing for re-emergence in terms of terrorism perspective. The research question was formulated based on the research problem to find answer for how does the LTTE re-emerge after three decades of deadly war to fight for a separate state? The analysis was carried out based on the theories applied in terms of terrorism perspective to answer the research hypothesis that due to long standing unsolved

socio-economic and politics issues augmented with external factors such as Tamil diaspora and Indian Tamil Nadu influence could contribute to re-emergence of LTTE cells in Sri Lanka.

## II. HISTORICAL BACKGROUND TO THE CONFLICT

### B. Pre-conflict Era.

The disparity between Tamils and Sinhalese goes back to the time that Sri Lanka achieved independence in 1948 from the British government. However, rivalries of two ethnic groups emerged even before, in times of the external threats from South India after the formulation of clear Sinhalese and Tamil ethnic or cultural identities in the 9th century. Forces of Sinhalese nationalism perpetuating notion of eternal conflict with Tamils had been gathering momentum over time. Moreover, until early the 1980s, ethnic conflict concerned mostly to political violence with minimal destruction of property and life. Velupillai Prabhakaran, the founder and supreme leader first came to public attention in 1983, when he shot and killed the mayor of Jaffna. Since then, war entered cycles of combat and negotiations. Neither externally nor internally has efforts brought about solutions. The Indo-Sri Lankan accord and the induction of Indian peacekeeping forces were classic examples of major external action in the initial history. Apart from that, many peace negotiations took place under different presidents and governments without any viable solutions. However, in mid-2006, the government of Sri Lanka declared war against the LTTE and conducted a large-scale offensive to end the thirty years' civil war. With the death of the LTTE supreme leader Prabhakaran, this war ended in 2009.

### C. Post-conflict Era.

After three decades of long battle, apart from the restoration of normalcy in the North and East, there are major challenges that the government of Sri Lanka has to face, in terms of humanitarian crisis, establishing rule of law, maintaining macro-economic stability and most importantly countering extremism and terrorism. At present, there are over 12000 ex-combatants who have surrendered or a detained at the end of the war (Keenan, 2010), who need to be released and re-integrated to the society; while fare numbers remain in detention without proper/pending legal prosecution. Above factors are issues of greater importance that the government of Sri Lanka needs to address in its reconciliation process in

the post conflict scenario. At present, the government has established a Commissioner on Reconciliation to address the post conflict situation including humanitarian issues pertaining to the conduct of the war. On the other hand, the demilitarization of the North and the East and actual implementation of 13th amendment (de-evaluation of power) to the constitution are other impending issues which, GOSL needs careful consideration. So far, the process could not be implemented because of lack of required majority in the parliament.

## III. CAUSES FOR RE-EMERGENCE

The nationalistic motives of the Tamil people could also be a root cause for re-emergence of the new LTTE cells in Sri Lanka. As Daniel Byman points out, "Ethnic terrorist groups begin to struggle by strengthening ethnic identity," (1998, p. 150). Two different nationalist ethnic identities different from religious, language and other cultural values contested for a small piece of land to be ruled by them. The Sri Lankan society is a multi-ethnic and ethno-religious society with clear religious divisions. Further, to a certain extent, ethnicity and religion also have a strong regional basis, which is significant enough for the Tamil Tigers to demand a separate state in the Northern and Eastern Provinces. On the other hand, the relationship between Tamil and Sinhalese is strained from the ancient times. This resulted after the periodic external threat posed by the South India, thus demonstrating further social cultural deviation.

Access to political and economic resources made socio-economic division among the Tamil and Sinhala communities. Donald Horowitz, in *Ethnic Groups in Conflicts*, has contributed the major theory to explain the root causes of ethnic conflicts and secessionist movements, both highly applicable to the Sri Lankan context (2008, p.3-5). According to Horowitz, an ethnically based party system, especially when the major group in control is divided by intra-ethnic party divides, can exclude minority groups (2008, p. 1-5). The Tamil people in Sri Lanka exposed to a number of disparities that provoked feeling of a frustration and discontent that caused violent group mobilization and conflict among the ethnic groups in the past. At present, many issues pertaining to politico-economic have been addressed by the existing government. But, as claim by the Tamil people, there are number of issues to be addressed based on the 13th Amendment.

The emergence of an active Tamil diaspora is a novelty because it has produced a different dimension to the conflict. In *What Next for the Tamil Tiger*, author John Thompson highlights that support for homeland terrorism among immigrants and the exiled group goes back to the old story of Russian socialists and Irish Republicans in nineteenth century. LTTE did not have a diaspora to draw support at the beginning, so they created one. The diaspora concept is different from other entities, the nature of the role, however, depends on how the central government deals with its Tamil population in the country.

The next issue is that the de-militarization in the Northern and the Eastern provinces. As Jonathan Tonge highlights, the military presence and reaction of the British forces in Northern Ireland, a similar military concept to Sri Lanka during its conflict. Tonge points out that when there is greater military presence, violence increases and the relationship between government forces and people declined due to security policies and measures (2006, p. 63-67). During the war, a large number of troops had been deployed in the North and East to fight the terrorism. According to the new aspiration of the Tamil community, de-militarization is one of the most important agenda in their political context.

Naturally, the Sri Lankan government has maintains a significant military presence even after reducing some elements in the area because the country has seen some LTTE movements and links with Islamic states that have been reported in Sri Lanka in the post conflict situation. Keeping the security view of militarization, the majority of the Tamil people have opposed military presence in the North and East. As Ami Pedahzur and Arie Perliger identified, the military aggression over Palestinian Arabs increased the violence in the Israel during the Israel-Palestine conflict (2008, p. 352-355). The controversial environment in Sri Lanka could also create an unpleasant situation among the Tamil people in the North. As such, this situation made possible for the Tamil Nadu and Tamil diaspora to support LTTE cells to operate in the Northern Sri Lanka as an underground organization.

Lastly, if any state support from the region or outside the region to nationalistic/terrorist elements in the north; there is a danger of resurgence of terrorism. As every other terror organization, LTTE also needs external support to exist. As Robert J. Art and Louise Richardson identified, "External actors play a number of parts both positive and negative," and most of the time they do support terrorist movements to achieve political rights (2007, p. 95-97).

According to the Donatella della Porta, "In this context strong ties are more important than weak ties" (1992, p. 15). As such, apart from the political parties in Tamil Nadu, various non-political groups like students, Chennai Branch of the all India Bar association and element of writers contributed their support to the Tamil in Sri Lanka, their ultimate demand is to support for the creation of a Tamil Eelam as a solution to the ethnic problem. These indications are the legacy of the Tamil tigers continues to live on with different perception in post conflict situation.

### III.EFFECTS OF THE RE-EMERGENCE

An increase in criminal activities could be a critical indication of a new approach to terrorist movements. According to Louise Shelley, a professor of crime and terrorism argued that terrorist often supported by crimes, and frequently changes identities as criminals and terrorists (2008, p. 342-345). While the guerrilla force has been defeated, the new Tamil tigers can provide many opportunities to conduct covert illegal activities. The covert operations included global mafia, the activities in terror network, and criminal activities. Professor Rohan Gunaratna, the head of the International Centre for Political Violence and Terrorism Research highlighted that people smugglers have organized more asylum seekers transported to Australia by boat from Sri Lanka, India and Indonesia. Further, former LTTE combatants smuggle people across the globe. Even after dismantling the LTTE in Sri Lanka in 2009, their overseas network is intact and the group remains active in Tamil Nadu in India, Northern Sri Lanka, Western Europe and Australia, collecting money, raising funds and holding financial resources, businesses and properties in overseas for future terrorist activities.

Recent insurgents' activities are classic indications of the re-emergence of the LTTE cells. Martha Crenshaw identified a "Distinct pattern of organizational evaluation;" basically Crenshaw points out that over time groups form, split, merge, collaborate compete, decline and grow (1981, p. 379). This theory is more applicable to the present Sri Lankan context because approximately 2,000 or more ex-combatants who escaped the arrest during the Humanitarian Operation, live in Sri Lanka or Tamil Nadu India or abroad. Since 2009, several attempts have been made by the LTTE to regroup and reorganize inside and outside the country from 2012 to 2014.

The first attempt was made on March 2012, by former LTTE cadre known as Kumaran who lived in Paris recruited 15 ex-LTTE cadres in Tamil Nadu for clandestine operations in Sri Lanka. Further, these groups have been organized into three cells of five members to carry out killings at Trincomalee; however, the mission did not succeed due to betray by themselves.

The second attempt was reported in December 2012, a group of ex-LTTE cadres including a top leader, expert in explosives, with financial assistance from overseas, entered Tamil Nadu to recruit and indoctrinate Sri Lankan Tamil youth with the LTTE ideology, but, the police arrested them at Chennai house in India with incriminating documents, electronics circuits and panels.

The third attempt occurred in March 2014, the hunt of former LTTE cadre, Gopi who opened fire on a policeman during a routine check in the Kilinochchi area. The government forces immediately cleared the area and arrested Gopi with a metal detector that allowed him to find arms and explosives dumped by the LTTE during final stage of the battle. These isolated indications suggest of undercover operations by the small cell LTTE combatants in this post conflict situation.

## IV. ANALYSIS OF TERRORISM PERSPECTIVE

Having identified the causes and effects of re-emergence of the LTTE in Sri Lanka let us now identify how the terrorism can exist in democratic countries, and a comparative analysis of terrorism perspectives.

### D. Ideological aspects of terrorism

Terrorists ideology can be considered as beliefs, values and objectives of a group that finally lead to achieve political objective or end state. In practice, most of the groups' ideologies are common to each other specially, separatism, religion, liberalism, anarchism etc., These ideological categories are "Not mutually exclusive and it is perfectly possible for a group to hold more than one political aspiration"(Drake, 1998, p. 52). The leaders of different terror and political groups usually have specific ideology with clear political objectives. On the other hand, ideology stands out as an obvious choice of distinguishing characteristics such as groups that aspire to change political status of certain political region, which include a degree of independence from existing nation-state. Classic examples

are Euskadi Ta Askatasuna (ETA) in Spain and the Irish republican Army in Northern Ireland (IRA) and Hamas for Palestine independent state that had their ideology to establish independent states. According to terror ideology, as Martha Crenshaw discussed, nationalist ideologies are moderate, stronger and cognitive to radicalization because of their roots in a community are united by memory and tradition (2006, p.5-9). As such, the LTTE in Sri Lanka also have the ideology of creating a separate state, which has appeared over a period, because of their aspirations are stronger, united by memory and tradition. The LTTE manifested with separatism ideology to draw attention of Tamil population to attain political objectives of new facet of terrorism.

### E.. Motivation and underground organization

Motivation is a driving factor for the individuals to join terrorist organizations. Many scholars have identified that individual choices and rational for such choices may lead individuals to join the terrorist organization. As Donatella della Porta identifies, social networks play a vital role in political socialization and personality building (1992, p.4-5). Porta main points is that participation in interpersonal networks is more important, because it allow more time an individual to spend political activities and contact with political comrades, thus allowing individuals to take part in more and more militant activities (1992, p. 5-9). This was clearly displayed by the Irish militants in Northern Ireland. On the other hand, Martha Crenshaw discusses that individual motivation towards underground organization (2006, p. 6-9). The general idea of the argument is what motivates individuals to become terrorists and what degree of ideology actually influences individual motivation to join organization. The findings point out that atmosphere of violence has a particular influence on those who are just beginning to take interest in political activates. The Palatine militants against Israel, IRA in Northern Ireland are classic examples. Furthermore, when youths are from lower family background, especially lower-middle class such as farmers, craftsmen, tradesmen, skill workers or employees are more attractive in underground organizations, this was well displayed in ETA and IRA. After the conflict, LTTE often operate in Sri Lanka, Tamil Nadu and other Western countries. LTTE main aim is to attract more youth and fight for their political objective. New groups are vulnerable because of the experience that they had during the brutal battle against government forces and the other groups who have no experiences, since they have fled to Western countries during the escalation of the military actions. Therefore, individual motivation towards



organization and conduct violence to achieve political objective is critical factor of terrorism perspective.

#### **F. Diaspora and terrorism**

According to different scholars, the debates on diaspora and conflicts have many aspects. One aspect is that diaspora can create negative and positive impact to conflict situation. According to Paivi and Adile “The best way to conceived of the role of diaspora in conflict is to think of the various phases or stages of conflict (conflict emergence, continuation escalation, termination and post conflict reconstruction) and then to evaluate the possible role diaspora may play in each phase”(2009, p 6-7). In terms of negative perspective, these communities are more effective in fundraising, recruitment, procurement of weaponry and lobbying of adopted government. For example, Kurdistan Workers Party (PKK) has engaged in political and fund raising activities, half of the organizational budget came from the Kurdish diaspora in Europe. Additionally, lobbying also plays a vital role in conflicts, the IRA affiliated USA diaspora did not allow United States to sale arms and ammunition to Britain. Diaspora members are generally remaining away from the conflict zone and contribute via financial and political means. Tamil diaspora has its long-standing history of contributing all negative aspects to the conflict in terms of financing, recruitment, procurement and maintain transnational government of Tamil Eelam. Despite the military defeat of the LTTE, Global Tamil forum network remains intact, and at present actively pursuing the objectives of the LTTE.

#### **G. Organizational structure of the terrorist**

A terrorist organization's structure, membership, resources and security have its impact on capabilities and reach. Any organization has its own concept to function efficiently and effectively. Many scholars argue that the period before nineteen century was marked as traditional or old terrorism, which can be divided as ethno-nationalist, separatist terrorism and left- right wing terrorism. Above all Martha Crenshaw also identified that distinct pattern of organizational evaluation, as group from, split, merge, collaborate, compete, shift ideological direction, adopt or renounce terrorism, grow, shrink, and eventually decline over time (2010, p. 5-8). Martha's view is important to understand, how terror groups emerge from set of competition groups to dominate violent against the government (2010, p.7). Provisional IRA in Northern Ireland is a classic example of re-emergence

after some time to take the lead to straggle against the British crown, and old IRA was renamed as Official IRA, which continued over a period to conduct limited terrorist campaign. Terror organizations develop simply because of political or religious grievances. New threats or organizations develop due to the motivation and rational of the groups itself and more importantly the community that provides the terrorist with support. Considering past experience of terror organization and how they re-emerge as violent political threats, it is obvious that LTTE could also develop their organization with splinter groups of ex-combatants, diaspora, Tamil Nadu refugees to achieve their political aspiration.

#### **H..Leadership and terrorism**

Leadership in the terrorist organization is vital in the large protracted conflict. Leaders are likely to emerge sequentially, hold the positions of power at the same time. There are generations of leaders such as early leader, follow-on leaders, continuity leaders and third generation leaders. Early leader, who formed, established and lead terror groups during the initial existence of the organization. The PIRA in 1969-1975, and ETA from 1950 to early 1980, and recent history al Qaeda, Osama Bin Laden classic example of early leaders category. Most significantly, third generation “embryonic” leaders are important because they are young and highly motivated and modify and expand the organizational goals according to new strategies and directions. LTTE in Sri Lanka at present lacks proper leadership; however, the younger generation could play a role in fulfilling the leadership vacuum. Raised and educated in the West and holding many university degrees, most of the young Tamils have become more active in the Tamil diaspora and Global Tamil forum. As such third generation “embryonic” leader could replace the vacant leadership of ex-military leader Vallupillai Prabhakaran and modify the political goal of the LTTE in near future.

## **IV.FINDINGS AND CONCLUSION**

So far, this paper has discussed the causes and effects of re-emergence of the LTTE, and how terrorism can be re-emerged with a comparative analysis to terrorism perspective. Accordingly, following factors have identified as possible contributing factors for re-emergence of LTTE in Sri Lanka. First and foremost, long-standing unaddressed political grievances are critical for re-

emergence of the LTTE since minority rights have been undermined by the government of Sri Lanka from the ancient history. Socio-economic instability, devolution of power, Sinhalese nationalist ideology with Sinhala as a main language triggered the grievances of the Tamil people. Even after thirty years of deadly battle, still some grievances are claimed to be untouched. Secondly, as every other diaspora in the conflicts, Tamil diaspora also played a vital role in Sri Lanka in terms of coordination of Tamil terror network, financing, and maintaining Transnational Government of Tamil Eelam, which empowered to coordinate all terrorist activities in Sri Lanka. Thirdly, Tamil Nadu as a close partner to Sri Lanka cannot be overruled in its influence over the clamour for Tamil Eelam. So far, three decades of long battle Tamil Nadu approach towards the Tamils of Sri Lanka have historical ethnic linkage, the impact on Dravidian movement and Tamil nationalism assume enormous significance in re-emergence of LTTE cells in Sri Lanka.

The demonstration, violence, criminal activities and insurgents' movements in the recent past have drawn the attention of the government of Sri Lanka and many foreign countries. So far, there had been three attempts in North to mobilize insurgents' activities, but could not activated due to extensive military intelligence operations in the North. However, political demonstrations, aggression against the security forces are common in nature. All of these indications would be subsequent actions of re-emergence of LTTE in Sri Lanka.

In order to identify the rationale behind the re-emergence of terrorism, the paper analysed factors leading to terrorism in perspective of terrorism. The findings conclude as follows: one, most of the underground organizations splintered and remerged according to the organizational structure. Two, leadership in the terror organization is vital to conduct effective campaigns against government, the terror groups' ideology are common and all have one objective to achieve. Ethno-nationalist and separatists' terror has common ideology of achieving political end state. Three, organizations at time fragmented, merged campaigns, however, leaders replace the position of leadership sequentially as per their term. Four, diaspora plays a pivotal role for the existence of terrorism in terms of coordinating, funding, and procurement.

In conclusion, the catalyst for the re-emergence of the terrorism in Sri Lanka is a classic example of the re-emergence of IRA in Northern Ireland. Tamils in North Sri Lanka did not enjoy their political rights from the

ancient history. Devolution of power and socio-economic disparity has led the minority Tamils to take up arms and fight against the government, but the struggle terminated in 2009 because of total defeat of the LTTE. However, the Tamil people have not abandoned the struggle for separate states. Tamil diaspora, Tamil Nadu and other external influences strengthen their struggle to exist with a separate identity. So far many attempts have been taken place to carry out new insurgency movement in the North, but could not succeed due to large-scale military presence in the North and East. Lack of leadership, coordination slowdown the movement of the terrorist activities, but LTTE network abroad conduct covert operations to support re-emergence of the LTTE cells in the post conflict situation. As such, this paper identified that due to long standing unsolved socio-economic and party-political issues augmented with external factors such as Tamil diaspora and Indian Tamil Nadu influence, could contribute to re-emergence of LTTE cells in Sri Lanka.

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# THE STRATEGIC IMPORTANCE OF SRI LANKA IN INDIAN OCEAN REGION: REFERENCE TO STRING OF PEARLS STRATEGY

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**Abstract** - China's interest in maritime silk route and continues energy flow to the country has resulted as "String of Pearls" across the Indian Ocean Region (IOR). In the 21st century, China came into the scenario of balancing the power of South Asia which generates a rivalry among India and China in Indian Ocean. Sri Lanka sits at the heart of the Indian Ocean, and holds one of the pearls of that string of pearls.

The study focused on 'to identify of the strategic importance of Sri Lanka within the Chinese String of Pearls Strategy in Indian Ocean Region'. The methodology that followed for this study is qualitative in nature by using only secondary data with descriptive analysis.

The theoretical approach of the study is based on the small states theory and China's peaceful rise theory. As per the study, the findings are elaborated in the following sectors; 'String of Pearls' in Indian Ocean, Sri Lanka and the rivalry between the Elephant and the Dragon, Strategic importance of Sri Lanka 'the Diamond' and losing the pearl from our hands. In the conclusion of the study, it reveals that the strategic importance of Sri Lanka in Indian Ocean has attracted the world's big powers.

The China's presence in Sri Lanka has been mutually benefited to Sri Lanka as well as China and the regime change of Sri Lanka has resulted in leasing the Hambantota port in order to meet the short term requirements of the country. Besides the political debates, Sri Lanka could use the pearl for the sustainability of the country and enhancing relations with the big powers of the world rather than accomplishing short term requirements.

**Key words** - Strategic Importance, Sri Lanka, String of Pearls, Indian Ocean Region

## I. INTRODUCTION

Since the ancient time, Indian Ocean Region (IOR) has attracted the great powers attention due to the economic value rest on the Indian Ocean in context of East and West maritime trade. In the 21st century, the region had performed a tremendous role which has impacted on the international politics. The current importance of the IOR is subjected to prove the statement of Alfred Mahan which says that "Whoever controls the Indian Ocean dominates Asia. This ocean is the key to seven seas. In the twenty-first century, the destiny of the world will be decided on its

waters" (Ali, 2013). This statement speaks the volume of the importance of Indian Ocean in the world. Being part of this strategic ocean mass, Sri Lanka has attracted the attention of the world's big powers due to its strategic location in the region.

Indian Ocean region comprises 38 littoral states, 24 ocean territories and 17 landlocked countries while Indian Ocean covers 20% of earth and it is ranked as the third largest water body of the world. However, US allies and key trading partners are highly dependents on the Indian Ocean for energy such as Japan receives 90% of oil via the Indian Ocean while 75% of China's oil imports and 85% of India's oil imports are transited through the Indian Ocean. When it comes to the economic importance of the Indian Ocean, approximately 30% of world trade is handled in the ports of the Indian Ocean along with the half of the world's

container traffic passes through it. In addition, 40 out of 54 types of raw materials used by U.S. industries are supplied by the Indian Ocean. The economic value of the Indian Ocean has facilitated the other states in the region to uphold such importance for the big powers of the world. Sri Lanka is one of the most strategically prominent states in the Indian Ocean region as a small state. As Sri Lanka lays a close proximity to the regional super power as well as to the main sea routes, it is observed that the two giants in the Asian region have made the presence in Sri Lanka by various means. With the China's Maritime Silk Road initiative, the strategic importance of Sri Lanka has been enhanced by being part of the 'String of Pearls' strategy over Indian Ocean. As a small state in the South Asia, Sri Lanka has tightened her knot with the Dragon as well as the Elephant in to sustain the country's development process.

## II. METHODOLOGY

The methodology that has used for the study is qualitative in nature and descriptive analysis method has been followed to analyze the gathered data. For the study, only secondary have been used. The theoretical framework has been featured with the small state theory and the China's peaceful rise theory. Conceptual wise, the concepts of maritime security, balance of power, and regional cooperation have been applied for the study.

## III. FINDINGS

### A. String of Pearls' in Indian Ocean

The initiative of the 'String of Pearls' strategy can be described as manifestation of China's soft power through economic assistance towards the littoral states of Indian Ocean Region to develop their ports. The concept of string of pearls strategy became popular in the beginning of the 21st century which includes and maintains by the use of economic, diplomatic, political and military means. The concept of 'peaceful co-existence' which China has strategically used in their conduct of foreign policy with the small states of South Asian countries has facilitated China a clear entrance into their territories for economic means. The expected objective of initiating this strategy of China is the strategic placement of these 'pearls' with one another in order to make a chain of hubs that can serve as both economic as well as military and intelligence cores in Indian Ocean region. In elaborating this study, it is essential to understand the 'Maritime Silk Road' and

'String of Pearls' strategies of China. The Maritime Silk Road concept was emerged during the Chinese President Xi Jinping's visit to Southeast Asia. This strategy is somewhat parallel to the land base Silk Road which runs between China and the Central Asian states. Zhou Bo (2014), a fellow with China's Academy of Military Science, wrote a piece for China-US Focus specifically debunking the idea of the "string of pearls." Zhou rejected the notion that China was establishing military bases throughout the Indian Ocean. He writes, "China has only two purposes in the Indian Ocean: economic gains and the security of Sea lines of Communication (SLOC) (Marantidou, 2014).

In implementing the string of pearls strategy, China has currently succeeded in asserting their presence in the countries of Pakistan, Sri Lanka, Bangladesh, and Myanmar in South Asia by financial assistance to develop their ports. Meanwhile, China has established the following in order to achieve her objectives:

- A container ship facility in Chittagong, Bangladesh
- Started the construction of deep water port in Sittwe and Kyaukyu in Myanmar
- A navy base in Gwada, Pakistan has been constructed which the Beijing has funded.
- A pipeline through the Islamabad and over Karakoram highway to Kashgar in Xinjiang Province in China
- Intelligence gathering facilities on islands in the Bay of Bengal near Malacca Strait
- Hambantota port in Sri Lanka (Ali, 2013).

Even though, the string of pearls strategy is purely on economic means in nature, indirectly the strategy serves the military requirements. As China is nowadays highly depending on the energy sources, many scholars have stated that the main objective of the string of pearls strategy is to ensure the steady flow of energy resources to China from the Arabic countries to their main land. Apparently, the Malacca Strait is a hub of U.S.A., China wanted to avoid the threat of US and maintain their dominance over the sea route. In addition to the sea routes, China has been initiated the land routes of railway and pipelines across Pakistan, Myanmar to China's main land.

This strategy of China has encircled the India who is the big brother of South Asia. It is interesting to note that

China is never admitted the concept of 'String of Pearls', while the strategy of maritime Silk Road is been clearly specified with the expected goals in an official manner. Among the pearls of the string that China holds in the Indian Ocean, Sri Lanka would be the diamond which is strategically enriched as the center point of Indian Ocean.

### **B. Sri Lanka and Rivalry between the Elephant and the Dragon**

Currently, the balance of power in South Asia fluctuates between India and China. Both giants are powerful actors who have rapidly growing economies and both countries have their own trade relations besides the rivalry. China's main interest in South Asia is to expand its power over the Indian Ocean which is concerned as most significant maritime trade hub. China's two way trade seemed at around \$3.5 trillion (2011 estimate). The combined value of India's merchandise exports and imports was around \$750 billion in 2011. Most of this trade is seaborne.

The protection of the sea lines of communication became an important commercial concern as well as the principal justification of naval bureaucracies in both India and China (Mohan, 2012). Since 77% of China's oil comes from the Middle East and Africa, Beijing has increased its activities in the Indian Ocean region by investing in littoral states' economies, building ports and infrastructure, providing weaponry, and acquiring energy resources. China has followed two effective strategies to approach the other countries in South Asia that it can invest in those countries for future benefits.

Those are the China's string of pearls strategy and Beijing's "hexiao gongda" policy in South Asia: "uniting with the small"- Pakistan, Bangladesh, Nepal, Burma, and Sri Lanka "to counter the big"- India. According to the John Garver, he argues that there are two ways the conflict might play itself out: "China could agree that South Asia is India's security zone and sphere of influence and [thus] desist from actions there which are objectionable to New Delhi," or "India could accommodate itself to a seemingly inexorable growth of China's political-military role in South Asia" (Garver, 2001). Even though China is becoming more powerful in South Asia, India is still the historic major player in South Asia. With the new leadership of Prime Minister Narendra Modi, Indian is now in a strategy to regain their hegemonic power across the region.

In the context of balance of power in South Asia, countries like Sri Lanka have to have the ultimate benefit of both giants in the scenario. Such small and developing countries do not have to fully depend on one country or two. They need to have cooperation with all giants in the region to sustain their development. Especially, Sri Lanka as a country that recently defeated terrorism, need much financial and political support from the regional heads to ensure its stability. In the meantime Sri Lanka has strong economic ties with India as well as China. However, the volume of Sri Lanka's exports to China does not yet seem comparable to that vis-à-vis India.

However, the trade balance has remained constantly in favor of China. India has become one of the top five countries investing in Sri Lanka mostly in the services sector like health, education, fuel distribution, hotel industry, tourism, IT training, computer software, and airlines industry. China is now poised to overtake India as Sri Lanka's biggest trading partner despite Sri Lanka benefitting from the Free Trade Agreement (FTA) with India which has helped India-Sri Lanka trade to grow to \$ 5 billion by 2011. But even without the FTA, China's bilateral trade figures reached nearly 50 per cent of the Indian figure (Hariharan, 2014). Even though, China tend to be more favorable for Sri Lanka, as a small country in South Asia the situation need to be handled carefully. In this situation Sri Lanka need to maintain a neutral position in between these two countries. How Sri Lanka navigates through this geo-strategic line of India and China in the Indian Ocean would test its diplomatic skills. Sri Lanka's relations with China are likely to be smooth for the foreseeable future because by policy China does not interfere in the internal affairs of country and its strategic interests are covered by the 1963 agreement.

### **C. Strategic Importance of Sri Lanka 'the Diamond'**

The strategic location of Sri Lanka in Indian Ocean has been emphasized by the leaders of the World wars, as the Grand Admiral Raeder, the German C-in-C had amply highlighted the Ceylon in a report to Hitler on 13th February 1942 "Once the Japanese battleships, aircraft-carriers and submarines and the Japanese Air Force are based on Ceylon, Britain will be forced to resort to heavily escorted convoys if she desires to maintain communications with India and the Near East.

Plans to strike westwards into Indian Ocean and seize Ceylon had been prepared by the staff of Japanese Combined Fleet...". Such significance of Sri Lanka has

attracted China to make her a one of pearls of Chinese maritime chain of ports in Indian Ocean. Due to the location of Sri Lanka in Indian Ocean despite of its size, the role Sri Lanka in terms of ensuring the maritime security of Indian Ocean is significantly vital. According to Robert D. Kaplan, in book of "Monsoon", he has identified few countries as 'Monsoon Asia' which includes India, Pakistan, China, Indonesia, Myanmar, Oman, Sri Lanka, Bangladesh and Tanzania while explaining how these countries are import to American power. Further, he states that these areas will be either the winning or losing grounds of democracy, energy independence and religious freedom (Brewster,2015).

Another factor in terms of strategic value of Sri Lanka is that as the Indian Ocean is rapidly becoming one of the most important ocean mass in global maritime trade, most of the maritime trade sea routes are around Sri Lanka. In the shipping traffic destiny maps it can be clearly identify that the key arteries of the maritime shipping trade which run South of Sri Lanka. A slightest disturbance to any of the ships which transit in Southern tip of Sri Lanka can cause huge impact on the international maritime trade. Moreover, in term of protection to these routes, Sri Lanka is directly linked to the security of Sea Lines of Communication (SLOC) which is a primary objective of China to establish their roots in Indian Ocean Region.

In terms of surveillance of maritime space, Sri Lanka has an important role to play due to its strategic location in Indian Ocean. Even though, the size of the territory of Sri Lanka is comparatively smaller than most of other states in South Asian Region, Sri Lanka forwarded the submission to extend the Exclusive Economic Zone in 2009. The expected territorial sea after the delimitation will be closer to 75000 square kilo meters. If Sri Lanka would archive this, in 2025, the country will take over under its control of an area of sea which will be 24 times large as the country's land area (Brewster,2015). At this point, Sri Lanka will be the key player in ensuring the maritime security in the region. To accomplish such goals, Sri Lanka need to well equip with naval platforms, sensors, long range maritime patrol craft and other tools to monitor the smallest fishing vessel to the biggest merchant ships sailing in Sri Lanka maritime jurisdiction.

The close proximity to the regional giant, India is one of the most significant strategic values of Sri Lanka in the region. Due to the less territorial distances between Sri Lanka and India, close relations of the two countries always ensure the mutual security requirements. In the recent times, the

relations between Sri Lanka and India have been disturbed due China's presence in Sri Lanka. As the Dragon and the Elephant is in long term conflict, India's perspective is that China's presence in Sri Lanka would be a threat to the security of the country. The suspicious is that China might use Sri Lanka as the back yard to attack India. In the meantime, the to ensure the territorial integrity and the security, the strategic location of Sri Lanka has always compel to conduct cordial relation India as well as China for the sustainability of the country.

#### **D Losing the Pearl from Our Hands**

The Chinese funded project of Hambantota port is located within 10 nautical miles of the world's busiest shipping lane, and it is ideally directed at the inter section of major international sea trading routes. This port has been destined to become the prime port of Sri Lanka, surpassing the Colombo harbor. Apparently, it is the world's first in built harbor which was carved out of land. The most strategic features of the Hambantota port can be figured as follows:

- The natural depth along the coastline can be developed into a deep water port.
- It is well positioned to act as a transshipment center rather than any Indian port due to the strategically situated maritime gateway to India (for transshipment container cargo).
- In view of the deeper berths and location, the port will be able to attract the most port related industries as cement, fertilizes, automobile etc.
- The port basin could be used for the services of vessels of bunkering facility and for the lager fishing vessels.
- Due to the major shipping route is much closer by shore off, this port could undertake the services such as ship channeling, supply of water, fuel, crew changes etc. In addition, supplies of coal generation and transshipment of vehicles also can be undertaken by the port (Ali, 2013).

Such strategic value is worth enough to be a pearl in the maritime port chain of China in Indian Ocean. Mutual benefit of the commercial relations is relayed on the functioning of Hambantota port, It has tightened the Relations with China and weaken the relation with India. Due to the regime change of Sri Lanka, criticisms were

raised claiming that the Hambantota port is a failure. Even though those criticisms are on political debates, the actual value of the Hambantota port is already recognized by the both countries.

Nowadays, the government of Sri Lanka is in position to return the pearl to the dragon in a way of leasing the port for 99 years (80%) to a Chinese company that can be extended to another 99 years. Two Chinese companies had tendered proposal, which have been considered without defining the criteria for selection. The first proposal was a one-time payment of U.S. \$ 108

0 million for a 99 years and the second proposal was an initial payment of approximately U.S. \$ 730 million for a 50 years period (Ranasinghe, 2016). However, the first proposal was accepted by the Sri Lanka Ports Authority (SLPA) and the main objective of leasing the Hambantota port is the need of immediate funds for the Country. On the other hand, the current government has voted in preventing the country from becoming a Chinese colony. When it comes to the annual income that have earned from this port in such period was as; in 2011-Rs. 11 million, in 2012 – Rs. 135 million, in 2013 – Rs. 565 million, in 2014 – Rs. 1,277 million and in 2015 – Rs. 2, 145 million (Ranasinghe, 2016). In the meantime, the government wanted to have short term commercial benefits by entering into private-public partnership of Hambantota port rather than developing a strategic plan to increase the flow of annual income into the homeland. Moreover, the government is also offering a stretch of lands amounting of 20,000 acres to the Chinese company including the port area which can be highly industrialized zone in future. It will benefit to the local civilians in terms of employment opportunities.

#### IV.DISCUSSION

The world's rapidly growing economic giant, the Dragon has made Sri Lanka one of the pearls which is the most strategically significant for U.S.A. as well as India. China has invested in Sri Lanka in various sectors including the Hambantota port and the Colombo port city project which are more important to Sri Lanka. Strategically, China considers ties with Sri Lanka as key to the success of its Indian Ocean policy.

It realizes that Sri Lanka is the gateway to resource rich regions of Middle East and Central Asia, especially Iran, a vital exporter of oil to China (Rajan, 2015). For China,

Hambantota will not only be an important transit for general cargo and oil but a presence in Hambantota also enhances China's monitoring and intelligence gathering capabilities vis-à-vis India. According to Garver's argument, China as a super power in South Asia would be more advantages to Sri Lanka as per the present situation.

China is the nation who helps Sri Lanka as an all-rounder. Indian has expressed its displeasure about growing Chinese involvement in Sri Lanka on a number of occasions. In 2007, India's then-national security advisor had openly criticized Sri Lanka for attempting to purchase a Chinese-built radar system on the grounds that it would "overreach" into the Indian air space (Courtesy, 2012). In between the rivalry among the giants, Sri Lanka needed to maintain its relations with both countries respectively. The strategic location of Sri Lanka is important to India in the context of its national security. The most important factor is that the initially, the government of Sri Lanka invited India to undertake and fund the project of Hambantota port. After the refusal of India, Sri Lanka turned into the side of China for partnership in constructing the port of Hambantota.

China has become an all-weather friend to Sri Lanka who has not interfered into the internal political issues and a supportive character in international politics. The theory of peaceful rise is successfully adopted by China in enhancing the relations with states of South Asia while using their soft power over these countries. In addition, in the recent history Sri Lanka and China has experienced a balanced relationship rather than Sri Lanka and India. In the string of pearls strategy in Indian Ocean, Sri Lanka, Pakistan, Bangladesh and Myanmar are the countries that hold the ports in this chain. The regional cooperation among these small states can be witnessed in a positive manner.

As Sri Lanka is situated at the center of Indian Ocean, the strategic value is immense in international maritime trade sector. Moreover, the most important maritime shipping routes are drawn in south of Sri Lanka which the traffic flow across the choke point. Ensuring the security of this choke point is directly relates with the protection of the vital Sea Lines of the Communications (SLCO). To achieve the primary goal of China in South Asia, presence in Sri Lanka is significant to China to maintain uninterrupted flow of energy to the country.



Since energy is critical in influencing the geopolitical strategies of a nation, any disturbance to its supply has serious security consequences. Oil and gas- laden ships travel from the Persian Gulf, transit via the Strait of Hormuz, around Sri Lanka through the Malacca Straits into the waters of the South China Sea. Subsequently, the Colombo South Harbor is another strategic point which Sri Lanka holds in terms of trade and commercial purposes with the world. It is important as a transshipment harbor while handling more than 70% of containers bound to the neighboring countries. As Sri Lanka has entirely eliminated terrorism from its territory, it resulted in encouraging the regional giants to invest in Sri Lanka. The strategic location of Sri Lanka can also play a vital role ensuring the maritime security of the region in collaboration with the regional powers.

In the meantime, the high peaked relations with China have disturbed the relations with India. Yet again, Sri Lanka needs to have a strategically neutral approach in dealing with the Indian Ocean strategic competition and should especially take the Indo-Lanka relations very seriously as a recent poll by the Lowy Institute in Australia suggested that “more than 80% of Indians view China as a security threat, even though China has become India’s largest trading partner” (Dodamgoda, 2013). Sri Lanka has experienced several negative outcomes by India for having close relations with China in the regional and international platforms.

In the meantime, China has been one of the strongest supporting giant in international politics. Even though, China is commercial more benefited to the country, in the regional context, the traditional hegemonic power over small state by India is unavoidable. Apparently, for a small state, having balanced relations with the big powers is effective to foster the development goals of the countries. Same for Sri Lanka, it need to have strong commitment to the immediate neighbor rather than being more close to the non-South Asian regional power. Apart from the strategic partnership between Sri Lanka and China, for the future prosperity of the country, Sri Lanka should build up a neutral position in conducting its foreign policy with the big powers in the South Asian region.

## V.CONCLUSION

The strategy of string of pearls of China and India’s Indian Ocean Strategy are competing together on the notion of balance of power in the South Asia, while the small countries like Sri Lanka are struggling to make their dreams successful to sustain the country. Being able to

obtain ultimate advantage of its strategic priorities in the Indian Ocean, Sri Lanka has become the Diamond among the pearls of that string.

The roles that Sri Lanka should play in ensuring the maritime security and overcoming the security challenges in Indian Ocean Region are vital in nature. All of these will be only possible to achieve for Sri Lanka, when Sri Lanka could maintain a neutral and balanced relations with India and China.

The strategic importance of Sri Lanka in Indian Ocean is vastly admired and identified by the international actors. As a developing nation, Sri Lanka need to obtain the expected development goals by using its strategic values rather than losing them to accomplish short term necessities.

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# IMPACT OF GIS MODELLING IN MILITARY OPERATIONAL PLANNING

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**Abstract** - The operation planning process takes considerable time and requires sound intelligence regarding the battlefield in preparing a successful operation plan. It is a globally accepted fact that sound planning and preparation well before an operation gives an immense advantage to the success of any battle. The Intelligence Preparation of the Battlefield (IPB) process is an important aspect in the operation planning process in the modern battlefield. Speed of the output, flexibility, timeliness, accuracy and future usage are essential parameters in this process. The IPB process is conducted using manual overlay drawing methods in Sri Lanka at present. The research proposes a Geographic Information System (GIS) model in conducting the IPB process using ArcGIS software. It was found that the proposed GIS model has the advantages of time saving, easiness, accuracy, flexibility and future usage than the manual method which is used in carrying out the IPB process in the country. The research also introduces a Model Builder Application to conduct terrain analysis as part of the IPB process which increases the speed of the proposed GIS method. However, Defence authorities in Sri Lanka are still lagging behind in introducing GIS to the operational planning process. The research also focused in finding the reasons for not using GIS and identified that lack of training on GIS, lack of knowledge on GIS application and lack of IT resources are the reasons for the limited usage of GIS in the military. Finally, the research recommends introducing GIS based platform not only for conducting IPB process but also other operational planning processes.

**Keywords** - GIS, IPB, Battlefield

## I.INTRODUCTION

It is globally accepted fact that sound planning and preparation well before an operation would give an

immense advantage to the success of any battle. The operation planning process takes a considerable amount of time and requires sound intelligence about the battlefield to prepare a successful operation plan (Creveld, 1985). Terrain analysis plays a vital role in military operational planning process and requires considerable time. Though commanders have a well-trained staff at their headquarters they face numerous difficulties in operation planning process due to these reasons.

In Sri Lanka IPB process is conducting by manual overlay drawing methods. Traditional 1:50000 printed maps

published by the Department of Survey and various overlays prepared on talc sheets fulfil the requirements of ingredients required for the IPB process in the military. This study focused to introduce a method to conduct the IPB process using GIS. The research could be useful for the Sri Lankan forces to adopt digital overlay drawing methods for the IPB process.

### A. Research Problem

In the context of Sri Lankan military, Information Technology (IT) plays a major role in most of the sectors such as communication, logistic, human resource management, etc. However, there are some lapses towards its applications to operational planning. The Sri Lankan military is far behind in using digital technology in comparison to defence forces of other countries.

In the modern battlefield, the IPB process is an important aspect for the MDMP. In this process, speed of terrain analysis and accuracy of the overlays are immensely important. Basically, the IPB process in Sri Lankan military is done by using manual overlay drawing methods. Preparing overlays manually for IPB takes considerable time and it generates a heavy workload to the staff since the battlefield is subject to rapid changes in time and space.

Further, the enemy would change the COA according to the changes in the battlefield and continuing with the IPB process make it uncomfortable to the staff during the operations. Flexibility of editing overlays according to the changes in the battlefield is important factor to consider in this regard. Preparing manual overlays for rapidly changing enemy situations of a battlefield casts a heavy workload and editing manual overlays generates lot of difficulties to staff officers in hectic situations. Moreover, manual overlay drawings are personnel dependent and these drawings vary from person to person. There is a very little possibility to use manual overlays for another operation. These manual overlays can be used for only one operation. If the area of operation changed, it requires to conduct a new IPB process.

GIS is basically used to analyse the geospatial data. It is an analytical software which can be effectively used for spatial analysis. The reason for not using GIS for IPB process in the Sri Lankan military is worthy of study. It is expected to develop a GIS model which shows the potential of conducting IPB process using GIS. The research will facilitate to reduce the uncertainty and enrich the reliability of incorporating spatial data with enemy doctrinal concepts and Commanders Critical Information Requirements (CCIR) in the IPB process.

**B. Research Objectives**

The objectives of the research are as follows:

- Primary Objective.  
Demonstrate the potential and investigate the impact of GIS modelling for the IPB process as an operational planning tool.

Specific Objectives are as follows:

- Develop a GIS model for the IPB process.
- Develop a ‘Model Builder Application’ to automate the terrain analysis of the IPB process.
- Derive the advantages of using GIS in the IPB process.
- Identify the barriers in using GIS for the IPB process.

**II.METHODOLOGY**

The research conducted in two stages. In the first stage, it was developed a GIS model and a ‘Model Builder Application’ using ArcGIS software. This requires the collection of relevant data from the government establishments.

The second stage is for conducting a questionnaire survey among the officers involved in the IPB process.

The questionnaire examined whether officers of different educational qualification could understand and use the proposed GIS model. The result of the questionnaire used to identify the pros, cons of the suggested method and identify the barriers of using GIS in the IPB process. The method will consist of quantitative and qualitative analysis.

**C. Conceptualization**

Presently the IPB process is accomplished in the Sri Lankan Military by using the manual overlay drawing method. There are some factors to be considered when conducting the IPB process, such as difficulty level, accuracy, timeliness, flexibility and further usage. The researcher introduces a new method to conduct IPB process by using the GIS software. In order to compare the manual IPB process and proposed GIS based method it considered above mentioned variables and compared both the manual and GIS methods as shown in Figure 1.

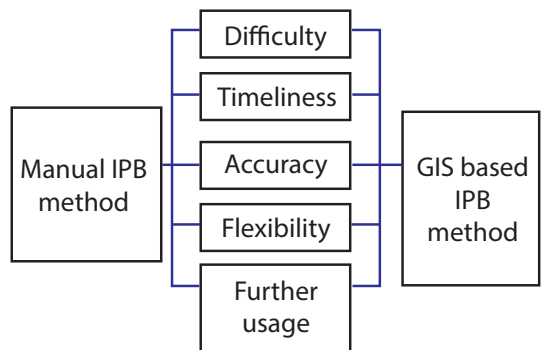


Figure 1 - Conceptualization

**D.Operationalization**

The operationalization of the concept was done through a questionnaire, which consisted of two main parts. The questionnaire focussed in obtaining the user views about the manual overlay drawing method and obtaining the user views about the GIS based IPB method. The questionnaire also focused in obtaining demographic data of the sample, which determine the educational background, GIS knowledge, computer literacy, etc. Other than the demographic data the questionnaire focused in deriving from the differences of manual IPB process and

GIS based process. Questions were focused to find out the user views of flexibility, accuracy, difficulty level, further usage and time saving factors.

### III.RESULTS AND DISCUSSION

Applying GIS technology for the operational planning process was demonstrated by developing a model for IPB process. Relevant terrain data was collected from Department of Survey and UDA by the researcher and it was observed that these institutions have a very expansive spatial data base. Developed GIS overlays were included in Chapter Three under the GIS model development sub topic. A picture of the GIS model is depicted in Figure 2. The objective of develop GIS model for the IPB process was achieved successfully.

Handling various overlays faces myriad of difficulties in the manual IPB process. The visualization of top most overlays are cluttered due to overlapping of overlays and only a limited area of operation can be seen due to space constraints. Handling GIS overlays required only a mouse click and it offers facilities to consider overlays separately for clear visualization. Further the GIS model offers vast flexibility in selecting area of operation due to the digital nature. A user can handle overlays of entire Sri Lanka in the digital screen. This technology can be used not only to conduct IPB process but also all the operational planning processes linked with maps and overlays in the Sri Lankan military. Silva (2007) also indicated the possibility of using GIS for the Sri Lankan military covering logistical activities, to locating, collecting and compiling military related information, etc.

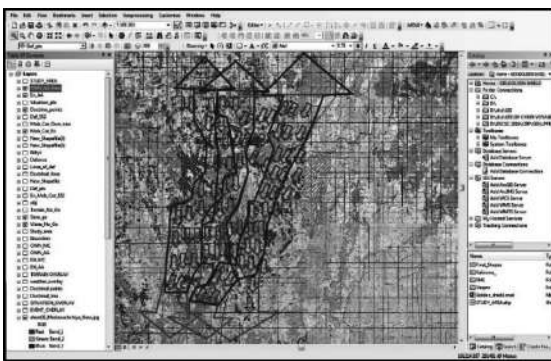


Figure 2 - GIS Model

The developed 'Model Builder Application' further reduced the time required for the GIS based IPB process. It also reduced the workload of the staff. This application was developed for preparing the Terrain Overlay of the IPB process and would benefit the users who do not have a fair knowledge regarding GIS. However, it is not possible to develop the 'Model Builder Applications' to prepare other overlays since the user uses a part of it to form decisions. Figure 50 indicates the developed model builder application.

#### E. Advantages of Using Geographic Information System for the Intelligence Preparation of Battlefield Process

The questionnaire survey focused in finding the difficulty level, timeliness, accuracy, flexibility and further usage. It was found that all these parameters gave a positive value to the GIS method in comparison to the manual method. As per the results the GIS based method has the following advantages:

- **Difficulty Level:** In comparison with the manual method over 63 percent of the study sample mentioned that the GIS method is easy. Only 12 percent mentioned that the manual method is easier than the GIS method. Nearly 60 percent of the study sample mentioned that the manual method is difficult while only 16 percent mentioned that the GIS method is difficult when comparing the difficulty levels of the manual and GIS methods.
- **Time Saving:** Considering the time required in conducting the IPB process using the manual method and the GIS method, only 20 percent completed the process in less than 4 hours using the manual method. Over 66 percent of the sample completed the process in less than 4 hours when using the GIS method.
- **Accuracy:** According to Figure 40, 76 percent cannot assure the accuracy of the manual method. 73 percent mentioned that the manual IPB method is personnel dependant.
- **Flexibility:** When comparing the flexibility level of the manual method and GIS method 66 percent of the study sample mentioned that the flexibility of the manual method as low and 70 percent mentioned that the GIS method is flexible.

- Further Usage: Seventy three percent of the study sample mentioned that the further usage of manual overlays have little possibility and 70 percent mentioned that the further usage of GIS overlays have greater possibility than the manual overlays.

The research proposed a GIS model to conduct the IPB process using ArcGIS software. The research also introduced a Model Builder Application to conduct terrain analysis as part of the IPB process, which increases the speed of the proposed GIS method. This model demonstrates the potential in using GIS for operational planning in the Sri Lankan military. It was found that the proposed GIS model has the advantages of saving time, easiness, accuracy, flexibility and further usage than the manual method. The results clearly indicate the positive impacts of GIS modelling in military operational planning. Hence, it is important to use GIS for operational planning towards achieving success in the 21st century.

## IV.CONCLUSION

The IPB process is an important aspect in operation planning in the modern battlefield. Speed of the output, flexibility, timeliness, accuracy and further usage are essential parameters to depict the advantages of this process. Presently, the Sri Lankan military carries out the IPB process manually using overlay drawing methods.



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# *Engineering*

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“Facing the Dynamics in the Global Environment  
through Engineering Solutions”



## SESSION SUMMARY

### Plenary Session

The engineering plenary session theme was “Facing the dynamics in the global environment through engineering solutions”. The session started at 1430 hours at FOE 6-1 hall. The session was chaired by Senior Prof. R.A. Attalage, Deputy Vice Chancellor, University of Moratuwa, Sri Lanka. There were four speakers at the session. They are Prof. Ang Kok Keng, Prof. Dev Ranmuthugala, Prof. Margereta Lutzhoft and Prof. RGNDS Munasinghe.

The first speaker Prof. Ang Kok Ken is a Faculty member in the Department of Civil and Environmental Engineering at the National University of Singapore (NUS) since March 1987. His research interests include Computational Methods, Dynamics of High-Speed Rails, Hydrodynamics of Marine Multibody Systems and Very Large Floating Structures, with about 140 technical papers published in these areas. Presently, he is the Head of the Faculty of Technology Enhanced Learning (TEL) Unit and the Principal Investigator of a multi-million dollar government-funded research project on Multi-Purpose Large Floating Structures.

Prof. Ang Kok Keng Presentation at the plenary session is mainly based on free-floating self-stabilizing fuel storages on sea waters. According to the speaker, these innovative hydrocarbon storages of various capacities moored together by separate floating barges equipped with floating berths on the sides. “In Singapore, we are running out of land, where land is a valuable resource, so we need other means of finding how to put fuel storage terminals” Prof. Ang explained the background of the project. Proposed structures along with different conceptual designs and their basic geometrical properties have been presented to the audience. Furthermore, a video footage of small-scale laboratory simulation regarding to the stability of a selected design has been shown at the end of the presentation. One of the main questions produced from the audience is how these manmade structures contribute to erosion in the coastal areas and how do they effect the

sea currents after the establishment of such fuel storages. “Actually, from these floating structures, we expect lesser impact to the natural environment” Prof. Ang responded.

The second speaker of the plenary session Prof. Dev Ranmuthugala delivered his speech on Effects of Appendages on Underwater Vehicles. Prof. Dev Ranmuthugala is a Professor in Maritime Engineering at the Australian Maritime College, University of Tasmania. His research areas include experimental and computational fluid dynamics to investigate the hydrodynamic characteristics of underwater vehicles, behaviour of submarines operating near the free surface, stability of surfaced submarines, towed underwater vehicle systems, and maritime engineering education. He is currently on secondment to the Defence Science and Technology Group (DSTG, Department of Defence) as Group Head, Hydrodynamics and Hydroacoustics.

Starting the second presentation, Prof. Dev Ranmuthugala mentioned the importance of identify and quantifying the effects from appendages related to stability and manoeuvring control, sensors, propulsion, payloads, other exterior parts and also the design approaches of the underwater vehicles including the appendage configuration to minimize the detrimental effects from these outer surfaces especially in non-standard and off-design operational conditions. “The issue you have is these underwater vehicles are inherently unstable” Prof. Ranmuthugala used several simulation examples to support his status. And, how the collective arrangement of these appendages generally detrimental to the drag of the vehicle, how they create out-of-plane forces that can also lead to the trajectory and other navigational parameters of the vehicle resulting operational difficulties and safety problems were also subjected to the speech in addition to the extended computer simulations and images of design samples. As a response to the presentation, audience wants to know whether simulations modelled using large-eddy-

simulation approach, and what extent one may use direct numerical simulation with this regard. “The last stage we achieved in LES” Prof. Ranmuthugala stated .

The third presenter, Prof. Margereta Lutzhoft is a professor of Nautical Studies & Deputy Director NCPS Seafaring University of Tasmania, Australia. Her research interests include human-centred design and the effects of new technology mainly focuses on leading and building up the maritime safety research in the Human Factors group through close contact with the industry and projects With the third presentation titled as “Human-centred Design of Ships”, Prof. Margereta Lutzhoft delivered her speech mainly towards the need of human friendly interior in naval ships. “People always want something what they know, we should be asking what they need” Prof. Margereta stated. By providing several photographs of existing ship interior, the speaker tried to maintain an interactive as well as a friendly environment in the audience at the same time. Further, she mentioned how narrow areas with limited leg or headspaces with steep staircases lead to discomfort and increase the risk of injury. At the questions and answer period, “Why don’t we use technology to solve space problem in those ships” Prof. Ranmuthugala suggested from the speaker panel. Yes, actually these problems can be solved by design process, Prof. Margereta stated.

The fourth and last speaker of the session was Prof. RGNDS Munasinghe from Department of Materials Science and Engineering Faculty of Engineering, University of Moratuwa. He delivered his speech on “Development of Research Culture to Face Dynamic Global Environment”. Prof. Munasinghe is a faculty member of Department of Materials Science and Engineering at University of Moratuwa, Sri Lanka since 2009, and a Senior Consultant to Department of Mechanical Engineering, Open University of Sri Lanka, interested in research areas such as Failure of materials, Metal Corrosion and Metal processing. At the last speech of the session, Prof. Munasinghe explained the background of the presentation and its timeliness and affiliation to the ongoing theme of the conference. “Before we find the solution we need to know what exactly the problem is”, “as for most of the people, they don’t know what the problem is, they find solutions to the wrong problem,

then it is too late”, Prof. Munasinghe stated. And he moved the mindset of the audience further into the depth of the contents of the presentation along with the famous saying of Albert Einstein “I would spend fifty-five minutes defining the problem, and only five minutes finding the solution”. To define the problem, we need knowledge and knowledge comes from textbooks, expertise, internet and research. Where, the author identifies research as innovative thinking. “To do a research, we need research atmosphere”, “where we have to think what we are going to do and what we are expected to find”, “building a unique research culture in a university should be done in many stages and a tightly manner” the author, Prof. Munasinghe explained.

“So, you can’t just ask students or the lectures or staff to do research”, “because research is a different type of activity” speaker used examples from China, how global challenges faced by them and how they encourage innovation by increasing research funding. Prof. Munasinghe also provided the figures of funding in different nations during different timelines including China, Australia, Germany and Sri Lanka. According to the author, performing a research is like crating an artwork or composing music. It is like choreographing a dance item, where building a unique research culture should be done very carefully, “it should be initiated in the mind of the particular person, you can’t just go sit and do a research”, “Therefore, it should create freely but not forcibly”, “To do such creations you need peace in the mind” Prof. Munasinghe further explained. At the questions and answer period, Prof. Ranmuthugala from the stage highlighted the industrial research requirements which also needed to be addressed, “we are not developed to such level but we can move further” Prof. Munasinghe added.

The session chair Prof. Attalage mentioned the importance of guaranteeing research results and Prof. Munasinghe explained how the pressure build inside the researchers mind when they have targets to achieve, “reviewers will go through the proposals, but it is hard to see where we are going” Prof. Munasinghe further added.

## Civil Engineering - Session I

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The technical session was chaired by Prof. Ang Kok Keng of the Department of Civil and Environmental Engineering, National University of Singapore. The technical session speakers were Dr. Sailesh Shrestha, Dr. Dai Jian, Mr. DS Arachchige and Mr. BSM Mendis.

Dr. Sailesh Shrestha is currently working in the Institute of Lowland and Marine Research of Saga University, Japan. The title of his research was "Behaviour of Reinforced Full-Scale Embankment on Hard Ground in Phitsanulok, Thailand". He emphasized on effectiveness of different types of polymeric and metallic reinforcements in terms of behaviour of embankment. He mentioned about the reliability of PLAXIS 2D software to analyse the behaviour of embankments and concluded that it provided good results in Mechanically Stabilized Earth Wall (MSEW) side but not so in the Reinforced Steep Slope (RSS) side. He further emphasized that MSEW was more effective than RSS.

Dr. Dai Jian is a Research Fellow working on the Multi-Purpose Floating Structures (MPFS) research project at the Department of Civil & Environmental Engineering, National University of Singapore. The title of his research was "Response of a Floating Curved Pontoon Bridge Subjected to Tide Induced Water Surface Variation: an analytical approach". The author presented an analytical solution to the out-of-plane response of a curved floating pontoon bridge under tidal variations. He concluded that the solution had an excellent agreement when compared

with finite element analysis results. He further mentioned that floating pontoon bridges have an advantage compared to suspension bridges on the fact that they are portable and that they have minimal maintenance costs.

Mr. DS Arachchige is a civil engineering undergraduate of General Sir John Kotelawala Defence University and is currently working as a Design Engineer in CSEC (Pvt) Ltd. His research was on "Numerical Simulation of De-bonding of CFRP Strengthened Steel Beam". The author mentioned that properties of adhesive significantly affect the increment in load carrying capacity and also that de-bonding was the major drawback in Steel structures strengthened with CFRP. He concluded that increase in shear strength and elastic modulus of the adhesive significantly increased the load carrying capacity of Steel beams.

Mr. BSM Mendis is currently employed at Amberg Engineering in Uma Oya multi-purpose development project as a mining engineer. The title of his research was "Determination of Existing Relationship among Grindability, Chemical Composition and Particle Size of Raw Material Mix at Aruwakkalu Limestone". The author has carried out a time series and a scatter plot analysis to obtain a relationship between grindability and particle size. He concluded that lower grindability lead to a lower output and a negative impact to the whole process. He further mentioned that there was no exact relationship between grindability and chemical composition mix.

## Civil Engineering - Session II

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Technical session was chaired by Prof Ashoka Perera of University of Moratuwa. The technical session speakers were Mr. HPPM Pathirana, Ms. PP Jayasekara, and Mr. KW Indika.

Mr. HPPM Pathirana is graduate of General Sir John Kotelawala Defence University. The title of his research was “Locally available low-cost packing media for anaerobic filters to treat landfill leachate” the author declared that most municipal waste are biodegradable, therefore anaerobic filters are most suitable to treat leachate. In his study, Pathirana has tested some locally available low-cost material, including Quartz, saw chips, and quarry dust as packing media for anaerobic filters. The material was tested in a laboratory scale experiment. His findings were that, the turbidity removal efficiency lasted longer in the quarry dust filter than in mixed & saw dust filter. The author concluded that quarry dust & mixed filter can be used to treat leachate effectively. The author further mentioned that, the filter material was placed in a random order.

Ms. PP Jayasekara is currently working as a civil engineer at Sanken Constructions (Pvt.) Ltd. Her research topic was “Use of ozonation for degradation of glyphosate in potable water of CKDU prevalent areas” The author showed evidence that, Glyphosate, a constituent in agrochemicals,

is a causal factor for CKDU. And that ozonation is a promising solution for removal of glyphosate in potable water. This study has investigated the effectiveness of ozonation using a series of laboratory experiments. The conclusions of the experiments showed that ozonation can be used to remove glyphosate effectively. However, presence of hardness in water caused to decrease the rate of removal of glyphosate. The reason for this according to the author is that Ca and Mn ions react with glyphosate to create compounds.

Mr. KW Indika is currently employed at the National Aquatic Resources Research and Development Agency (NARA) as Development Officer in Research Project. The title of his research was “Sea level variability in the west coast of Sri Lanka”. In his study, the sea level variability in the west coast of Sri Lanka was studied by means of in-situ (tidal gauge) & satellite altimetry data, over a period from 1993 to 2014. He mentioned that he obtained the data from 4 stations situated in Sri Lanka which are interconnected to a global network. He further mentioned that the causes for the sea level variability were thermal expansion due to Ocean warming and melting of glaciers. He concluded that the maximum Sea level in the west coast of Sri Lanka was observed during December and the minimum sea level was observed during July – August.

## Electrical & Electronics Engineering

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Electrical and Electronic technical session was chaired by the emeritus professor at University of Moratuwa, Prof. J R Lucas also works as a senior professor at General Sir John Kotelawala Defence University.

The technical session speakers were Mr. SLD De Silva, Ms. Joy Vahini Varatharaajah, Ms. MAG Shashika, Mr. WADSS Weerasinghe and Mr. KAD Darhana.

Mr. SLD De Silva graduated in the Bachelor of Science Honors Degree in Electrical and Electronic Engineering at General Sir John Kotelawala Defence University. The title of his speech was "Designing a Remote Monitoring System for Improving the Reliability of Distribution Feeders in Sri Lanka". The paper is on designing a remote monitoring system for distribution feeders to address a problem of not having a proper mechanism to monitor the LV distribution network.

Ms. Joy Vahini Varatharaajah has obtained the BEng (Hons) in Electronic Engineering degree from Sri Lanka Institute of Information Technology. The title of her speech was "Single Carrier Communication System on Open Source Embedded Platform". This paper is a single carrier communication system on open source embedded platform where the proof of concept in this work shows the potential of software radio in off the shelf embedded hardware.

Ms. MAG Shashikala is a Demonstrator of University of Kelaniya. The title of her speech was "Time Series Modelling approach for forecasting Electricity Demand in Sri Lanka". This paper is a time series modelling approach for forecasting electricity demand in Sri Lanka and furthermore the proposed methodology has been successfully applied to the data related to the gross electricity generation and total electricity usage in Sri Lanka over the past fifty years.

Mr. WADSS Weerasinghe has graduated from University of Wayamba in 2012. Presently he is working as a research assistant continuing his postgraduate studies towards a degree of doctor of philosophy under NSF research grant. The title of her speech was "Fabrication and Evaluation of a Sri Lankan Graphite Based Rechargeable Battery" which reports about fabrication and evaluation of a Zn and graphite based battery that uses a gel polymer electrolyte instead of a liquid electrolyte.

Mr. KAD Dharshana is a Lecturer of a Department of Mechanical and Manufacturing Engineering, Faculty of Engineering, University of Ruhuna. The title of his speech was "A Novel Approach to Implement a Closed Loop Controlled Power Converter in Thermal Vacuum Tubes". This paper presented an approach to implement a closed loop controlled power converter in thermal vacuum tubes and has stated that this approach makes the filament supply voltage a reliable input regardless of the magnitude or a specific application.

## Biomedical Engineering

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The session was chaired by senior lecturer in Biomaterials and Tissue engineering Dr. James B. Phillips of University College London, UK. His basic research areas involve the use of tissue engineering principles to understand damage and repair in peripheral nerves and the spinal cord.

The plenary session speakers were, Mr. LR Vitharana, Mr. DMHT Dasanayake, Miss. BRMGWUB Balagalla, Mr. Rosharn Amarasinghe and Mr. WLPK Wijesinghe.

Mr. LR Vitharana is currently reading for his undergraduate engineering degree at the General Sir John Kotelawala Defence University in the department of Mechanical and Mechatronics Engineering. The title of his speech was "Autonomous mobile robot for disease detection and individual health monitoring of cattle in intensive dairy farms". He emphasized the lack of a proper autonomous system used for health monitoring of cattle in modern dairy farms where intensive farming methods. He proposed an autonomous mobile robot that can navigate from one cow to another using track skid locomotion mechanism and using thermographic and visual imaging cameras as sensors to detect physiological symptoms of popular cattle diseases using red colour on cow's face. He further added that the methodology would be completely non-invasive and be distress and discomfort free. It was also highlighted that a successful detection rate of 80% was obtained and the two main problems encountered were noise and pink colour being identified as red.

Mr. DMHT Dasanayake is also a current engineering undergraduate at the General Sir John Kotelawala Defence University at the department of Mechanical and Mechatronics Engineering. Title of his speech was "Smart hospital ward management system with mobile robot wardbot: an efficient management solution for hospital ward". He talked about hospital ward management system based on a six degree of freedom mobile robotic platform and a web application system to conduct basic duties of healthcare professionals in a public Sri lankan hospital like drug dispensing and syrup distribution. He further stated that the instrument would be calibrated for efficiency using the ratio of drug delivering time in prevailing system to that of the proposed system. He discussed how

separate canisters are assigned for separate drugs. He also shattered the opinion of the audience that "a nurse should accompany the robot all the time". Finally, he discussed about the positives of establishing such a system in a public hospital of Sri Lanka.

Miss. BRMGWUB Balagalla was a former undergraduate engineering student at the General Sir John Kotelawala Defence University and currently serving as a demonstrator at the Faculty of Engineering, University of Sri Jayawardenapura. Title of her speech was "Ayurvedic pulse diagnostic techniques to develop modern non-invasive disease diagnostic devices". Her talk was primarily based on ways to minimize the subjective errors and improve the accuracy of disease diagnosis by wrist pulse analysis which has been shown to be accurate as the biopsy tests and CT scans. She mentioned that electronic sensors such as piezoelectric sensors are used to sense the pulses and went on to state that the calibration and threshold of pulse signal depends on the Ayurveda practitioner. Problems were raised by the audience with regard to the disclosure of ayurvedic information by the respective practitioners/ organizations to third party researchers and she answered that these organizations has shown interest in conforming the obtained data are accurate indeed. Among the list of diseases, she mentioned that could be diagnosed by wrist pulse analysis, the audience claimed that acute appendicitis is not an Ayurvedic medical practice, in fact, a western medical practice.

Mr. Rosharn Amarasinghe is a business consultant Dynatech International and RoheConsultancy and a founding member of Crypto Gen Company. He also served as the secretary of the Young Professionals Organization secretary of the Young Professionals Organization. Title of his speech was "Expanding the quality of living with paraplegia: robotic exoskeleton technology". His study was focused on developing an exoskeleton structure to provide near-perfect mobility to those suffering from paraplegias. He mentioned that the proposed device would be a combination of mechanical and hydraulic concepts that allow body movement using microcontroller architecture. However, he noted that high cost is the barrier standing between paraplegias patients and this bionic exoskeleton. The weight of the device has been estimated to be around 23

kg. He also talked about tree climbers and people suffering motor traffic accidents to be the prominent contenders for paraplegias and concluded by saying that no prototype is developed so far however, he has gone through almost all the technical aspects of such a device .

Mr. WLPK Wijesinghe is currently serving as a lecturer at the General Sir John Kotelawala Defence University at the department of Electrical electronic and telecommunication Engineering. His research interests are biomechanics, motion analysis, biomedical signal processing and image processing. Title of his speech was "Motion analysis of badminton forehand smash shot using low frame rate cameras".

He mentioned that three 60 frames per second DSLR cameras had been used for analysis of the motion in badminton smash shot where blue coloured markers had been placed on the subjects' hand. However, he discussed that low frame rate in DSLR cameras yield information loss and in order to compensate this loss a suitable mathematical model is under development.

He also talked about the placement of player, camera angle and height from the ground are the key features of the reference frame. He further noted that the current system is developed only for two-dimensional motion analysis and it is now being modified to be used for three-dimensional motion analysis too. When questioned were raised about the method of validation of the results, he stated that no information about accuracy can be provided with standard laboratory and software.

## Mechanical/Aeronautical Engineering

The session was held as the 3<sup>rd</sup> session under the Faculty of Engineering and under the theme of “Facing the Dynamics in the Global Environment through Engineering Solutions”.

The session was chaired by Dr. Nirosch Jayaweera, Senior Lecturer, Department of Mechanical Engineering, University of Moratuwa. His expertise lies not only in academia but also in the industry as well. He has a post-doctoral research expertise working with Rolls-Royce, Airbus and Volvo Aero Corporation. He’s a Chartered Engineer in the UK, a Senior Member of the Society of Manufacturing Engineers(USA), a Member of the Institute of Engineering and Technology(UK) and also a member of the Institute of Electrical and Electronics Engineers(USA).

Four research papers were presented during the session. The first paper titled “Analysis of Test Section Flow Conditions of Low Speed Wind Tunnel” was presented by Mrs. JI Abeygoonewardene from General Sir John Kotelawala Defence University. The co-authors are Mr. DR Casseer and Ms. K Wickramasinghe from the same university. The presenter described the air flow characteristics inside a wind tunnel.

An Aerolab Low Speed Wind Tunnel was utilized as the test subject. Bernoulli’s Equation was used in speed calibration method. Static pressure and Dynamic pressure variations were graphically shown. Reynold’s number had been used in the calculations. Boundary layer mouse was used to acquire pressure readings. After the presentation, a question raised by the audience asking whether the research was performed taking only the ‘Laminar Boundary Layer into consideration. The Chair asked about the future work of the research and about further development.

The second paper titled “KF implemented Flying Wing” was presented by Mr. WDT Fernando from General Sir John Kotelawala Defence University. The main objective of conducting the research was stated as to perform a CFD analysis of a Flying Wing.

Factors to be considered when designing a wing were stated. Meshing had been performed on the models using ANSIS software. It was stated that the “Coefficient of Lift”

(CL) was larger in the proposed design than that of the existing designs. Several questions were raised by the audience.

It was asked about a comparison between the area of the proposed wing and the conventional wing. It was asked the reason for not stating the “Coefficient of Drag” (CD) in the research. Also, it was asked the reason for not including the “Y+” value in the wing design simulation. Also, the Chair asked whether there was any validation done in the research to prove that ANSIS results were accurate.

The third paper titled “An Outdoor Smart Robotic Garbage Bin to Assist a Methodical Garbage collection, storage and disposal process” was presented by Mr. MSR Wijenayake from General Sir John Kotelawala Defence University. The co-authors are Mr. NRW Gunarathne, Mr. PB Henadeera and Mr. KHT Devinka from the same university. It was a conceptual research and the prototype was not yet developed.

The research proposed a mobile bin concept. A method for Odor controlling was proposed. Wheels were used to make the bin move. Load cells were used to measure the weight of the dumped garbage. Stress analysis of the base frame was performed. Several questions were raised by the audience.

It was asked whether the track line was magnetic. Also, it was asked how the mobile-bin identified its initial position. Finally, it was asked whether there were any limitations for number of bins in an area. The Chair asked whether a cost analysis was performed. Also, the Chair asked how the stability was considered in dumping the garbage.

The final paper titled “Development of flexible productive work cell by collaborating work study and lean tools at a multinational tire company in Sri Lanka” was presented by Mrs. HAD Perera from University of Peradeniya.

The co-authors are HRN Silva, Director, Trainer of Knowledge Village, Sri Lanka and KA Weniton from the Business School, University of Wolverhampton, UK. This was a case study.



The main objective of this research was to develop a flexible work cell. The process that had been optimized in this research was revealed in steps. Root cause analysis was performed. "Gemba Walk" method was adopted. A work study was done in terms of a time study and a method study. The implementation process was revealed. The improved parameters were shown. (A comparison between earlier work cell and the proposed work cell). Two questions were raised by the audience. It was asked the reason for using Lean tools in identifying the bottleneck of the process.

Also, it was asked how it would affect the remaining workers if the workforce was reduced from 8 persons to 5 persons. After the presentations were concluded, the session was summed up by the Chair.

## Mararine Engineering

The session theme was “Facing the Dynamics in the Global Environment through Engineering Solutions”

Technical session was chaired by the Prof. Martin Renilson is the current president of The Royal Institution of Naval Architects (Australian Division). He has been working in the field of Ship Hydrodynamics for over 35 years. He established the Ship Hydrodynamics Centre at the Australian Maritime College (AMC) in 1983, and was Director of the Australian Maritime Engineering Cooperative Research Centre in 1992.

He started the Department of Naval Architecture & Ocean Engineering at AMC in 1996, which he ran until 2001 when he was appointed Technical Manager, Maritime Platforms & Equipment for DERA/QinetiQ in the UK. In 2012, he was appointed inaugural Dean of Maritime Programs at the Higher Colleges of Technology, United Arab Emirates, to start maritime education for the country. He is also an Adjunct Professor in Hydrodynamics at the University of Tasmania, Australia.

The technical session speakers were Dr WK Wimalsiri, Mr.Nirman Jayarathne, Lieutenant commander (E) Milinda Dassanayake, Lieutenant (E) Nipuna Rajapaksha and Lieutenant Commander (E) Arunoda Samaranayake.

Dr WK Wimalsiri is a senior lecturer in the Department of Mechanical Engineering at University of Moratuwa. He has an honours degree in Mechanical Engineering from the University of Moratuwa and completed his doctorate in Naval Architecture from the University of New Castle upon Tyne, UK. The title of his speech was “Probabilistic Approach to Assessment of Damage Survivability of Cargo Ships”. He brought out the two method of Damage Stability Criterion such as Deterministic Method and Probabilistic Method. Furthermore, he described about the survivability of ships during his presentation.

Mr. Nirman Jayarathne is an academic staff member of the Department of Marine Engineering at the General Sir John Kotelawala Defence University. Currently he is following a PhD at the Australian Maritime College, University of Tasmania. His research focuses on hydrodynamic interaction effects during close quarter ship manoeuvres.

The title of his speech was “Safe Operation of Tugs within Close Proximity to the Forward and Aft Regions of Ships”. He explained about the interaction between a tug and a ship while at operation and how the pressure regions change along the different section of the ships. He also brought out the CFD simulations carried out for understanding this phenomenon. Furthermore, he explained about the longitudinal and lateral forces acting between ship and the tug.

Lieutenant commander (E) Milinda Dassanayake joined Sri Lanka Navy in 2002 and completed his basic engineering course, marine engineering specialization course and Nuclear Biological Chemical Defence and Damage Control Course in INS Sivaji, India. Currently he is the Head of Department (Engineering) in Naval Institute of Technology, Sri Lanka Navy. The title of his speech was “Trending of Vibration Spectrum in Marine Diesel Engine, Marine Gear Box and Variations with Rotational Speeds”. He described the main classes of vibration, engine gearbox vibration, vibration condition and etc. He also brought the main bearing spectrum analysis.

Lieutenant (E) Nipuna Rajapaksha is serving in Sri Lanka Navy who currently is an academic staff member of the Department of Marine Engineering at the General Sir John Kotellawala Defence University. His principle research interests lie in the field of Naval Architecture and Marine Engineering.

The title of his speech was “Preliminary Concept Design of an Affordable Coastal Patrol Craft for Sri Lanka Navy”. He talked about a requirement of a multi mission capable coastal patrol craft for Sri Lanka Navy and the process of designing it using three points such as Planning hull, Modularity concept and Effect of learning curve.

He also described how to select the main particulars to the ship and brought out a in detailed description of stability, resistance and powering calculations to the design.

Lieutenant Commander (E) Arunoda Samaranayake obtained his BSc(DS) Marine Engineering(Hons) degree from General Sir John Kotelawala Defence University, Marine Engineering Specialization and Nuclear,

Biological & Chemical Defence Specialization from INS Shivaji, India. Currently works as a lecturer at Department of Marine Engineering at General Sir John Kotelawala Defence University.

The title of his speech was “Reducing Fossil Fuel Consumption in Naval Ships: A study on economical and eco-friendly power alternatives for naval ships

during peacetime”. He talked about the use of fossil fuel consumption during past years and Sri Lanka Navy budget for fossil fuel.

Then he proposed a method to save use fossil fuel for a ship. Further he emphasised that using the method he proposed can go for financial as well as environmental savings.

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*Plenary  
Speeches*

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# FLOATING HYDROCARBON STORAGE AND BUNKER FACILITY

**KK Ang<sup>1</sup>, J Dai<sup>1</sup>, BK Lim<sup>1</sup> and CM Wang<sup>2</sup>**

<sup>1</sup>Department of Civil & Environmental Engineering, National University of Singapore, Singapore

<sup>2</sup>School of Civil Engineering, University of Queensland, Australia

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**Abstract** – This paper presents the development of an innovative floating oil terminal for use in coastal waters. Entitled “Floating Hydrocarbon Storage and Bunker Facility” (FHSBF), this invention comprises several innovative free-floating self-stabilising storage tanks of various capacities that are moored together by separate floating barges housing processing facilities and are equipped with floating berths on the sides. As the key elements of this invention, the design and stability of the

self-stabilising storage tanks are discussed in detail. This paper also provides recommendations on the geometric properties of the storage tanks for a stability and cost-effective design.

**Keywords** - floating hydrocarbon storage facility, self-stabilising tank, very large floating structure, modular design.

# DEVELOPMENT OF RESEARCH CULTURE TO FACE DYNAMIC GLOBAL ENVIRONMENT

**RGN De S Munasinghe**  
University of Moratuwa

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As per the main theme, to face the dynamic global environmental challenges innovative engineering solutions are required and certainly, to find those solutions it is necessary to have new knowledge created through high-end research. For that a powerful research culture should be created within a particular industry, institution or university.

Development of a powerful research culture enhances the research potential of an institution. In case of universities it is well known fact that it has mainly three areas to serve the society. I.e. teaching, creation and dissemination of scientific & engineering knowledge as well as contribution to the national policy making process. Out of the above-mentioned areas creation of knowledge has a vital role to play in sustainable development of a university. Intensive research work is an essential element to create new knowledge. Hence, any university which needs to achieve an international recognition should give utmost priority

to promote research. Building a unique research culture in a university should be done in many stages and in timely manner. Since performing effective research is similar to composing music, creating an art work or choreographing a dance item, it should be initiated in the mind of a particular person.

Therefore, it should be created freely but not forcibly generated. For such a creation, certainly one needs 'peace in mind' and obviously, unlimited time. As Einstein has quoted "creativity is the residue of time wasted" one needs to spend time in intensive 'thinking'. Therefore, it is essential that to promote research a 'Research Atmosphere' should be created within the university. In addition to that availability of adequate funding, equipment, testing facilities, adequate infrastructure, less administrative restrictions etc. are other essential requirements for the development of an attractive research culture in a university.

# EFFECTS OF APPENDAGES ON UNDERWATER VEHICLES

**Dev Ranmuthugala and Zhi Leong**  
University of Tasmania, Australia

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Depending on mission requirements, underwater vehicles are designed and configured with a number of appendages. These include appendages for stability and manoeuvring control, sensors, propulsion, payloads, equipment, etc. The collective arrangement of these appendages is generally detrimental to the drag of the vehicle, and in many cases, can result in out-of-plane forces that can affect the trajectory and attitude of the vehicle, that in turn can affect its operational capability and safety. Therefore, when designing underwater vehicles, it is important to identify and quantify the effects from these appendages, and design the vehicle and the appendage configuration to minimize the detrimental effects from these surfaces.

Care should also be taken during operations, as the operator should be aware of these effects on the behaviour of the vehicle, especially in non-standard and off-design operational conditions. These include the location of the forward and aft control surfaces on its manoeuvring and propulsion characteristics, effects of the sail on the flow structure around the vehicle, effects of the flow on sensors, etc. Thus, the location and sizing of the appendages are important, although the final configuration is not totally dependent on the hydrodynamic characteristics. This presentation provides some guidance on the sizing, locations, and shapes of common appendages on a typical underwater vehicle.

# HUMAN-CENTRED DESIGN OF SHIPS

**Margareta Lutzhoft**

Australian Maritime College, University of Tasmania, Australia

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Throughout the history of shipbuilding, naval architects have mainly been looking at ships from technical and economical points of view. Generations of ship designers have made seagoing vessels more seaworthy, travel faster, having an increased transport capacity and a lower fuel consumption. Great effort has also been made in improving maritime safety. However, reports indicate that human errors are blamed for most maritime accidents, which raises the question: why do humans still perform errors

despite countless numbers of improvement in design and technology to assist them? The design of technology can have a big impact on how people perform. Most engineers are trained to design with a firm technical perspective, and sometimes create designs which may not match the needs of users. Fortunately, the influence of design on safety has been acknowledged, and relevant parties have started taking steps in developing a crew-centred approach to design or in simpler words, to “Design the problem out”.



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*Technical  
Sessions*

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(ORAL AND POSTER PRESENTATIONS)

# BEHAVIOUR OF REINFORCED FULL SCALE EMBANKMENT ON HARD GROUND IN PHITSANULOK, THAILAND

S Shrestha<sup>1#</sup>, DT Bergado<sup>2</sup>, T Hino<sup>1</sup>

<sup>1</sup>Institute of Lowland and Marine Research, Saga University, Japan

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**Abstract** - A full-scale test embankment (6 m height) constructed by Department of Highways, the Bureau of Road Research and Development in Phitsanulok, Thailand was simulated using FEM 2D. A surcharge fill of 1.2 m thick without reinforcements was added at the top of the embankment equivalent to 2 tsm of load. One side of this embankment was reinforced with polymeric reinforcements consisting polyester (PET), polypropylene (PP) and high density polyethylene (HDPE) and referred as reinforced steep slope (RSS), which is at an angle of 70 degrees from horizontal.

The other side of the embankment was reinforced with metallic reinforcements consisting of metallic strips (MS) and steel wire grids (SWG) combined with precast concrete panel and termed as mechanically stabilized earth wall (MSEW). The objective was to compare the effectiveness of different types of polymeric and metallic reinforcements in terms of the behaviour of the embankment and the reliability of the finite element method (FEM 2D) to analyse the behaviour of the embankment.

The simulated results were compared with measured data. The results obtained from FEM 2D have good agreement with the field measurements in terms of vertical and lateral deformations of the embankment at the MSEW side. However, there were discrepancies between measured data and FEM 2D simulations at the RSS side due to its limitations.

The FEM 2D simulation overpredicted the vertical settlements in the foundation which affected the prediction of the lateral displacements.

**Keywords** - Embankment, hard ground, FEM, metallic reinforcements.

## I. INTRODUCTION

Embankment reinforcement/MSE wall have become the widely-used method to control large differential settlement by increasing the tensile strength of the embankment soil [1,3,9,11,13,14]. Reinforcing the soil have many advantages compared with conventional reinforced concrete and concrete gravity retaining walls.

Proper design of MSE wall can lead to the use of fine grained marginal soils as backfill material for reinforced soil construction, providing important cost savings and new soil reinforcement applications to reduce cost of structures that would otherwise be constructed with expensive backfill; improved performance of compacted clay structures that would otherwise be constructed without reinforcements; and use of materials, such as, nearly saturated cohesive soils and mine wastes, which would otherwise require disposal, in civil engineering construction projects.

Numerical analysis has been a strong tool for predicting the performance of the reinforced embankment / MSE wall [2-3,4-6]. Further, Chai [7] have compared the behaviour of the embankment in the soft ground, whose foundation was improved with the cement deep mixing (CDM) columns with FEM 2D and FEM 3D. The behaviour of the embankment in terms of lateral and vertical displacements was well predicted by the FEM 2D and FEM 3D. Bergado [3] suggested FEM under plane strain condition can be

successively utilized to analyze the pullout and direct shear mechanisms as well as the behavior of hexagonal wire mesh reinforced embankment with silty sand backfill. Bergado and Teerawattanasuk [4] compared the reliability of FEM 2D and FEM 3D by studying two full-scale embankments; steel grid embankment having longer plan dimensions with length-to-width ratio of 3.0 (long embankment) and hexagonal wire mesh reinforced embankment having shorter plan dimensions with length-to-width ratio of 1.0 (short embankment).

The actual behaviour of the steel grid reinforced long embankment corresponded more closely to the results of the FEM 2D numerical simulations. However, the actual behaviour of the hexagonal wire mesh reinforced short embankment corresponded more closely to the results of the FEM 3D numerical simulations. The geometric effects were important factors that affected the results of the numerical simulations.

This study analyses the embankment (6 m height) constructed in Phitsanulok, Thailand consisting of Reinforced Steep Slope (RSS) and Mechanically Stabilized Earth Wall (MSEW) with high strength polymeric and metallic reinforcements using FEM 2D. The simulated behaviour of this embankment were compared with the measured data in terms of lateral and vertical displacements.

Then the discussions in relation with the observed results and data are done in the lateral section. The input parameters for the soil and reinforcements, backfill materials were obtained from the laboratory testing at Asian Institute of Technology (AIT) Thailand.

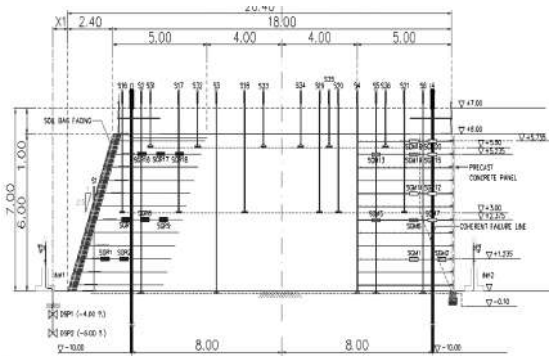


Figure 2 Cross section of MSE wall/embankment indicating the locations of monitoring instruments

## II. METHODOLOGY

### A. Description of the reinforced embankment

In the full scale embankment, reinforced steep slope (RSS) of 70 degrees from the horizontal with soil bags as facing was utilized in one side whereas mechanically stabilized earth wall (MSEW) with concrete panel as facing was used in another side. The test embankment with facing (RSS and MSEW) was designed up to a height of 6m. A surcharge fill 1.2 m thick was later added without reinforcement at the top of the embankment equivalent to 2 tsm load.

The length of the embankment was 18 m and width was 15m. Polyester (PET), polypropylene (PP) and high density polyethylene (HDPE) geogrids were used as polymeric reinforcements in the reinforced steep slope (RSS) whereas metallic strips (MS) and steel wire grid (SWG) were utilized as metallic reinforcements in mechanically stabilized earth wall (MSEW) facing of the embankment.

The vertical spacing between each reinforcement layer was 0.5 m and the length was 5 m while the upper layers of metallic strip from layer 7 to layer 12 had 5.8 m length. Different monitoring instruments were installed to monitor the vertical and lateral displacements, total stresses, excess pore water pressure, groundwater and strains in reinforcing material including inclinometers, settlement plates, total pressure cells, standpipe piezometers, vibrating wire strain gauges and fiber optic strain gauges.

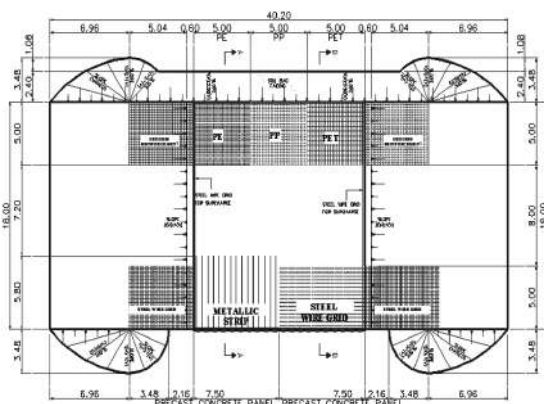


Figure 1 Plan of test MSE embankment

In addition, observation wells were installed to monitor the level of groundwater at the dummy area located more than 10 m from the embankment. The plan and cross-section views of the embankment along with the instrumentation points are shown in Figs. 1 and 2.

**B. Modelled parameters**

1) Backfill material: The material used as backfill in the embankment consisted of 50% lateritic soil mixed with 50% silty sand (by volume) and has moisture content and dry unit weight as 7% and 22.7 kN/m<sup>3</sup>, respectively. The friction angle and cohesion of this backfill material obtained from direct shear test were 42 degrees and 80 kPa. From triaxial (CU) test, the effective friction and cohesion were 37 degrees and 20 kPa, respectively. For the plane strain condition, the friction angle is converted by Lade and Lee [8] formula as  $\phi' = 38.5$  degrees. The various properties of backfill material are tabulated in the Table 1.

2) Metallic, Polymeric reinforcements and Precast concrete panel facing: The various properties of the reinforcements modelled as a geogrid material in FEM 2D are summarized in the Table 2. The image of the polymer and metallic reinforcements are also given in the Fig. 3. The comparison of the reinforcement stiffnesses from highest to lowest is as follows: metallic strip (MS), steel wire grid (SWG), polypropylene (PP), high density polyethylene (HDPE) and polyester (PET). Table 3 gives the properties of Rinterface parameter from Large-Scale Direct Shear Test testing conducted in AIT laboratory. In this study, the precast concrete panels were modelled using plate elements. The dimensions of the panel were 1.5 m width, 1.5 m height and 0.15 m thick. The axial stiffness (EA) and the poisons ratio ( $\nu$ ) of the panel was 42000000 kN/m and 0.15.

**III. NUMERICAL MODELLING**

The numerical analysis of the MSE wall/embankment was performed using FEM 2D in Plaxis 8.2 software [10]. The side boundaries were placed at a distance of two times the width of the embankment, and the bottom boundary was fixed up to the known soil layer. As shown in the Fig. 4, the mesh is created and the nodal points at the bottom boundary were fixed in both directions, and those on the side boundaries were fixed only in the horizontal direction. The in-situ stresses in the foundation soil were generated by the Ko procedure.

**Table 1 Soil properties of the backfill soil**

Property	Lateritic Soil Mixed with Sand (50:50 by Volume)
Atterberg Limit Test	LL = 20.8%, PL=17.3 %, PI=3.5%
Sieve Analysis Test	Percent Finer=0.94%, Cu=40, Cc=0.34
Unified Classification	Poorly Graded Sand (SP)
AASHTO Classification	A-2-4(0)
Compaction Test	Maximum dry unit weight ( $\gamma_d$ ) = 22.05 kN/m <sup>3</sup> ; Optimum moisture content (OMC) = 7.0%
Direct Shear Test	Friction Angle, $\phi' = 42$ ; Cohesion, $c' = 80$ kPa
Triaxial (CU) Test	$\phi' = 37, c' = 20$ kPa
Plane strain, Triaxial (CU) Test	$\phi_{ps}' = 38.5$

**Table 2 Material properties of reinforcements**

Material Name	Tensile Strength (kN/m)	Thick-ness (mm)	Axial Stiffness, EA (kN/m)
Metallic Strip (MS)	277.6	4.00	88000
Steel Wire Grid (SWG)	128.1	6.00	35000
Polyester (PET)	83.6	1.50	925
Polypropylene (PP)	91.9	1.45	1360
High Density Polyethylene (HDPE)	85.8	1.91	1320

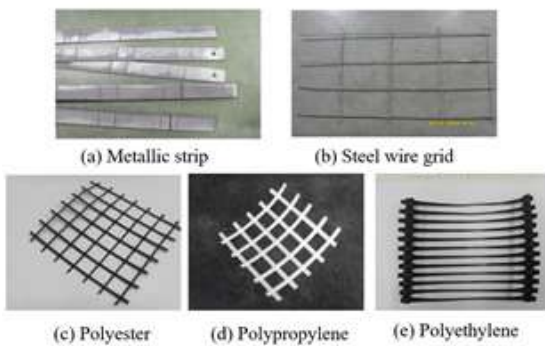
**Table 3 Interface strengths from large-scale direct shear test result**

Soil to	$\phi'$ (°)	$c'$ (kPa)	$R_{inter}$
Soil	40	23	1.00
Steel Strip	36	23	0.87
Steel Grid	40	28	1.00
Polyester (PET)	33	21	0.79
Polypropylene (PP)	35	25	0.83
High Density Polyethylene (HDPE)	33	24	0.77

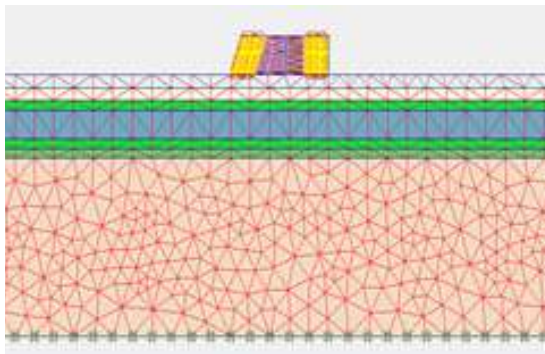
Then, the backfill which was divided into 13 layers, as in the field was placed on the foundation soil layer by layer.

After the placement of the compacted fill layer the reinforcement was placed at interval of 0.5 m vertical spacing until the completion of full height of the embankment. During this construction stage drained Mohr Coulomb analysis is used to simulate the layer by layer construction. After the completion of the full height of the embankment drained analysis is used to simulate the consolidation process for 186 days.

This constitutive model was characterized by five parameters: elastic parameters ( $E$ : Young modulus,  $\nu$ : Poisson's ratio) and plastic parameters ( $\phi$ : friction angle,  $c$ : cohesion, and  $\psi$ : dilatancy angle). The input parameters for the numerical modelling are summarized in Table 4. Finally, the simulated results were compared with the measured data which are discussed in the results and discussions section.



**Figure 3 Metallic and Polymer reinforcements used in the test embankment**



**Figure 4 FEM 2D of full scale reinforced test**

## IV. RESULTS AND DISCUSSIONS

### A. Lateral displacements

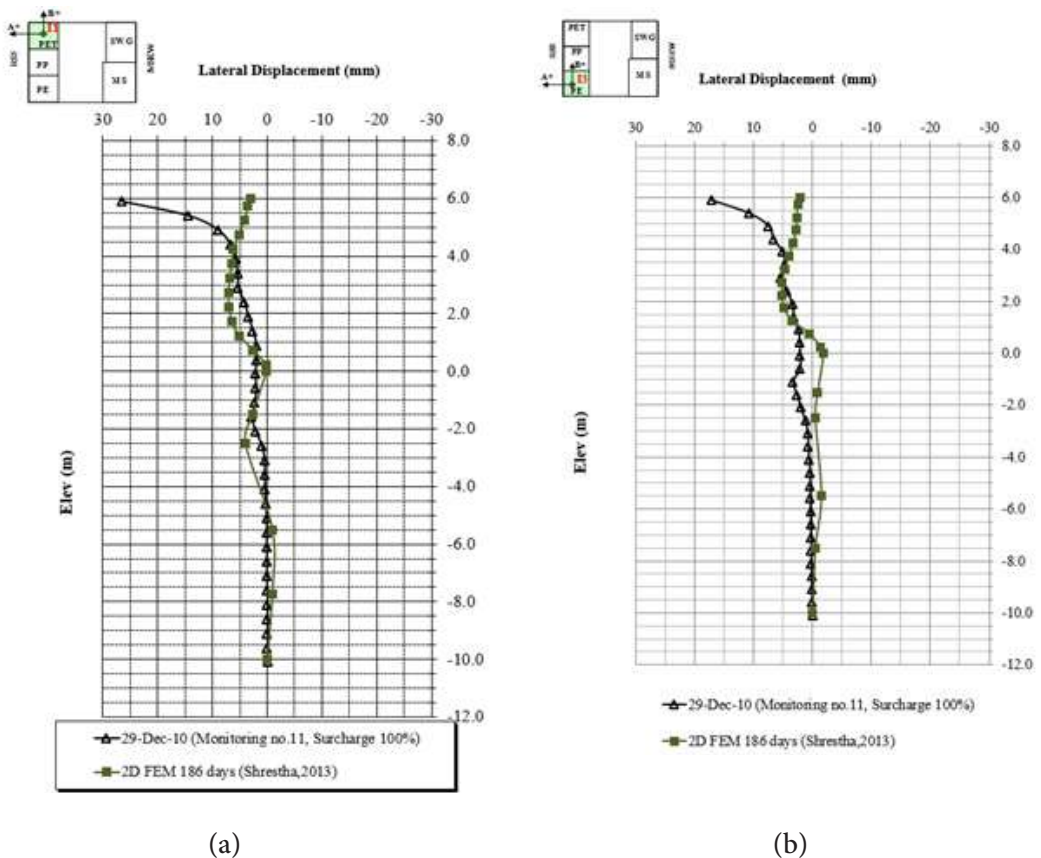
Based on the simulated results, the total lateral displacements were analysed and compared with the observed data. Inclinometers I1, I2, I3, I4 and I5 were used to measure the lateral displacements for the PET, PP, HDPE, SWG and MS section in the field (Fig. 2). The lateral displacements of PET, PP and HDPE on RSS side, and SWG and MS on MSEW side obtained from field measurement by inclinometers were compared with the data from numerical simulations at 186 days after the end of the construction (Figures 5 to 6). The FEM 2D (Shrestha, 2013) yielded the overall behaviour of the test embankment closer in the MSEW facing than the RSS facing. The results overpredicted below 4.50m height of the embankment on the RSS side. These discrepancies may be due to the limitations under plane strain conditions with asymmetric embankment structure. From the measured data, the lateral displacement of the RSS side with the HDPE have lowest lateral displacement at the top around 16 mm, while the side with the PET and PP (The compared data for the PP is not shown in this paper and can be referred to the Shrestha, 2013 [12]) have almost same amount of lateral displacement of 27 mm. Further, for the MSEW side reinforced with metallic reinforcements and with concrete panel as facing, the lateral displacements were comparatively very smaller around 10 mm. Thus, the higher stiffness of the metallic reinforcements contributed on reducing the lateral displacements.

### B. Settlements

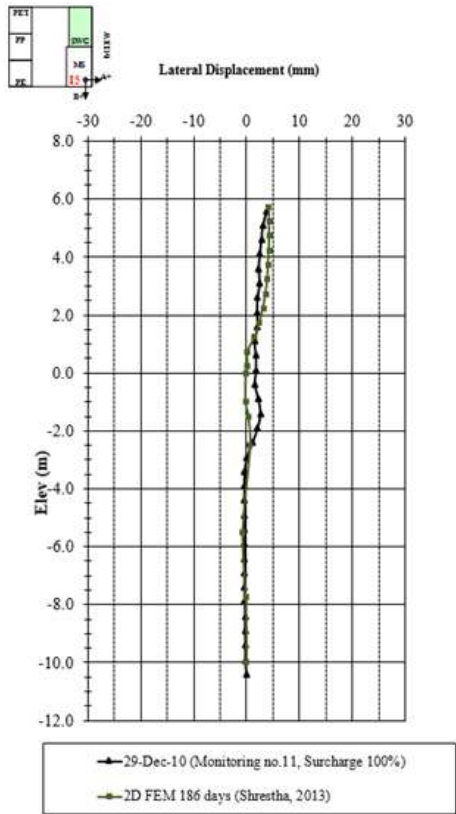
Surface and subsurface settlement plates were installed in the embankment at different heights such as S1 to S15 at the foundation (Level 0.00 m) to measure the vertical settlements and S31 to S45 at the top (Level 5.5m) to measure the compression of the embankment (Fig. 2). For the PET-SWG cross-section the maximum settlement at the base of the embankment (Level 0.00m) ranged from 30 to 100 mm at 186 days after construction. The compression of the foundation was found to be slightly higher at the RSS side as shown in Fig. 7 for this section. While, for the HDPE-MS cross-section the maximum settlement at the base of the embankment (Level 0.00m) ranged from 40 to 60 mm at 186 days after construction. The compression of the foundation was found to increase slightly towards the middle, as shown in Fig. 8 for this section. For both cross-section FEM 2D overpredicted the vertical settlements. The over prediction may be due to the

**Table 4 Material conditions and parameters used in the analysis**

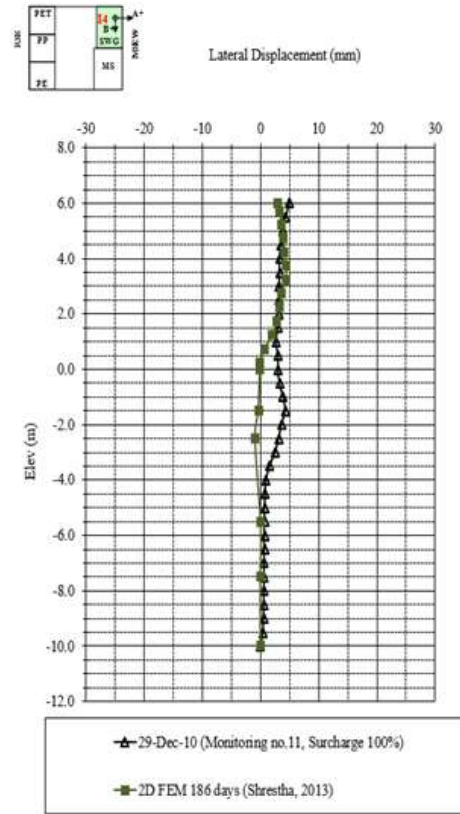
	Depth(m)	$\gamma_t$ (kN/m <sup>3</sup> )	$k_x(10^{-4})$ m/d)	$k_y(10^{-4})$ m/d)	$\nu$	E (kPa)	$c'$ (kPa)	$\phi'_{ps}(\theta)$
Backfill material	-	22.7	-	-	12,000	10	38.5	
Dense to very dense clayey sand	0-2	19	10	5	0.35	20,000	15	30
Loose clayey sand	2-4	18	10	5	0.35	15,000	7	34
Medium dense clayey sand	4-5.5	18	10	5	0.35	25,000	5	36
Very stiff to hard silty clay	5.5-10	19	1	0.5	0.35	50,000	70	28
Dense clayey sand	11.5-13	19	10	5	0.35	30,000	8	33
Hard silty clay	13-21.45	22	1	0.5	0.35	80,000	100	26



**Fig. 5 Observed and simulated lateral displacements of the (a) PET and (b) HDPE**



(a)



(b)

Fig. 6 Observed and simulated lateral displacements of the (a) MS and (b) SWG

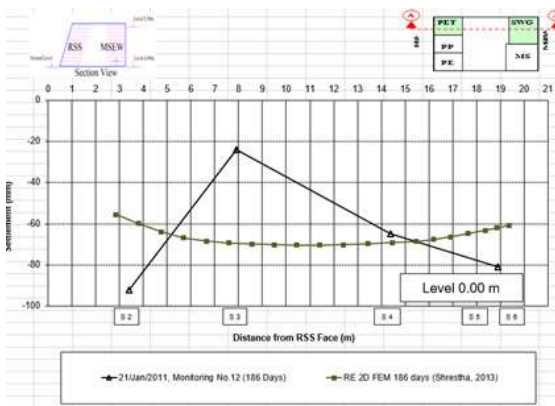


Fig. 7 Compression of the foundation at 186 days in PET-SWG cross-section

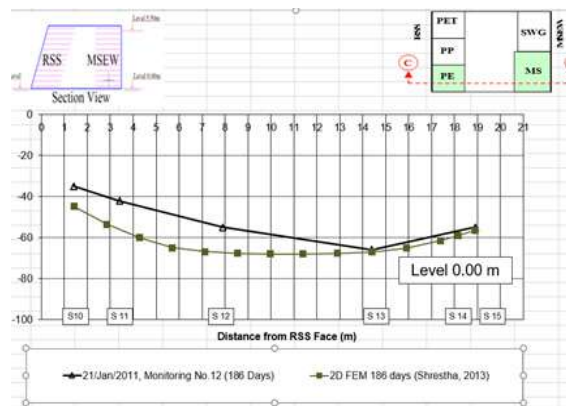


Fig. 8 Compression of the foundation at 186 days in HDPE-MS cross-section

limitation of analyses under plane strain condition with asymmetric embankment structure.

## IV. CONCLUSIONS

The full scale test embankment (6 m height) was constructed by Department of Highways in Phitsanulok, Thailand on hard foundation. The comparisons of the behaviour of both metallic and polymeric reinforcements were monitored and observed in terms of lateral and vertical displacements. The lateral displacements and vertical settlements in the MSEW faced side was less in comparison with the RSS faced side from monitored data. The RSS side has more settlement and displacement as a result of lower stiffness than MSEW side. For the polymer reinforcements, the RSS side with the HDPE have the lowest lateral and vertical displacement. For the MSEW side with the metallic reinforcements the lateral displacements were almost same for both type. The discrepancy between the measured data and the simulated data may be due to some limitations of the boundary conditions in FEM 2D for shorter embankments with asymmetric embankment structure and varying physical and engineering properties at short distances apart.

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# RESPONSE OF A FLOATING CURVED PONTOON BRIDGE SUBJECTED TO TIDE INDUCED WATER SURFACE VARIATION: AN ANALYTICAL APPROACH

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**Abstract** - Floating bridges are very effective solutions to linking space when the water depth is deep and/or the seabed is soft. However, they are subjected to the water surface elevation induced by the tide. This paper presents an analytical solution to the out-of-plane response of a curved floating pontoon bridge under tidal variations. Trigonometric trial functions are employed to approximate the vertical displacement and the torsional deformation of the curved bridge. The accuracy of the solution is examined through comparison against finite element analysis results. Excellent agreement is found between these results.

**Keywords** - Floating bridge, pontoon bridge, curved bridge, tidal variation

## I. INTRODUCTION

Bridges are essential in connecting islands and land parcels separated by a water body to boost economic and leisure activities. When water is very deep and/or the seabed is extremely soft at a location where a bridge is going to be built, conventional piers supporting the bridge become expensive or even impractical. Under these conditions, floating bridges may offer distinct advantages through the use of pontoons to support the bridge deck. The pontoons are supported by natural buoyancy forces and are not dependent on the sea bed condition. More importantly, if the bridge is to be relocated elsewhere when it is no longer needed, a floating bridge allows easy removal as it may be towed away by tug boats.

The use of curved layout in the floating bridge design

is very effective as the environmental loads acting on the pontoons are transferred to the bridge end supports through the bridge superstructure mainly in an axial compression or tension rather than in bending and shear. A curved bridge layout also results in significantly improved resistance to the rolling motion while the water current and waves are not hindered by the existence of the structure. Examples of curved pontoon bridges include the famous Bergsøysund Bridge (see Fig. 1a) built at Bergsøysund near Kristiansund, Norway, in 1992 (Watanabe and Utsunomiya, 2003). It is a horizontally curved bridge spanning 845 m with a 1300 m radius of curvature. This bridge consists of a steel pipe truss superstructure resting on seven concrete pontoons. At the bridge ends, the truss work is bolted to the abutment through a flexible rod (see Fig. 1b). The flexible rod is designed to transfer the forces into the abutment mainly in axial forces. It is also designed to provide some rotational capacity to enable the absorption of the relative vertical displacement due to tidal variation.



(a)



(b)  
**Figure 1. Bergsøysund Bridge:**  
 (a) the bridge and (b) flexible rod

Floating bridges can be very effective solutions for connecting lands separated by water. However, the tide induced sea water surface variation in some countries such as Singapore is large, about  $\pm 2$  m. Thus, it is important to examine whether a floating bridge has sufficient flexibility to adapt to the tidal variation.

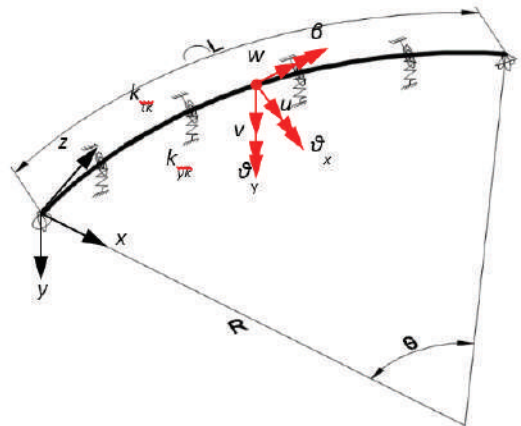
The analysis of curved structures using efficient analytical approaches has interested many researchers. This includes the studies on the out-of-plane free vibration of a curved beam (Wang et al., 1980 and Bickford and Maganty, 1986), analysis of a one-span curved bridge subjected to moving vehicle loads (Yang et al., 2001), the dynamic stability of a curved rail under a moving load (Nair et al., 1985) and steady-state response of a continuously supported curved rail subject to a sequence of moving loads (Dai and Ang, 2015). It should be noted that the aforementioned analytical studies were confined to the case of a single-span or continuously supported curved beam with homogeneous cross-sectional properties. For floating pontoon bridges, however, they are discretely supported by pontoons and their section may vary along its spans.

This paper presents an accurate and efficient analytical approach to the out-of-plane response of a floating curved pontoon bridge with arbitrary cross-sectional properties. Trigonometric trial functions are employed to approximate the vertical displacement and the torsional deformation of the curved bridge. The accuracy of the solution will be examined through comparison with finite element analysis results.

## II. METHODOLOGY

Consider a Euler curved beam with length  $L$ , radius  $R$ ,

cross-sectional area  $A(z)$ , flexural rigidity  $EI_x(z)$ , and shear rigidity  $GJ(z)$ . The beam is simply supported at the ends. The beam torsion is also restrained at the two ends. In addition, the beam is discretely supported at the locations of the pontoons owing to the buoyancy, as shown in Figure 2. By neglecting the inertia and viscous damping terms, the out-of-plane governing equations of motion (Dai and Ang, 2015) reduce to those for a static problem that can be written as



**Figure 2. Coordinates and degrees of freedom of curved bridge**

$$\frac{\partial^2}{\partial z^2} \left( EI_x(z) \frac{\partial^2 v}{\partial z^2} - \frac{1}{R} \beta \right) - \frac{GJ(z)}{R} \left( \frac{1}{R} \frac{\partial^2 v}{\partial z^2} + \frac{\partial^2 \beta}{\partial z^2} \right) + \sum_{k=1}^{N_p} k_{yk} (v - H_T - H_e) \delta(z - z_k) = \rho A(z) g \quad (1a)$$

$$\frac{EI_x(z)}{R} \left( \frac{\beta}{R} - \frac{\partial^2 v}{\partial z^2} \right) - GJ(z) \left( \frac{\partial^2 \beta}{\partial z^2} + \frac{1}{R} \frac{\partial^2 v}{\partial z^2} \right) + \sum_{k=1}^{N_p} k_{tk} \beta \delta(z - z_k) = 0 \quad (1b)$$

where  $v$  and  $\beta$  are the vertical displacement and torsional deformation, respectively;  $k_{yk}$  and  $k_{tk}$  the vertical and torsional hydrostatic stiffness, respectively;  $N_p$  refers to the number of pontoons;  $H_T$  and  $H_e$  are the tide induced surface elevation and the water surface elevation in the equilibrium state.

In view of the boundary conditions and the relationship between  $v$  and  $\beta$ , both vertical and torsional deformations of the curved beam can be expressed as the summation of a series of sinusoidal functions as

$$v = \sum_{i=1}^n q_{vi} \sin \frac{i\pi z}{L}, \quad \beta = \sum_{i=1}^n q_{\beta i} \sin \frac{i\pi z}{L}$$

(2)

where  $q_{vi}$  and  $q_{\beta i}$  denote the generalized coordinates of  $i$ th mode;  $n$  the number of modes. To solve the coupled differential equations, Galerkin's approach is adopted to formulate the weighted residual forms of the governing equations, which leads to  $i$ th mode governing equations

$$\sum_{j=1}^n a_{ij} q_{vj} + \sum_{j=1}^n b_{ij} q_{\beta j} = \rho g \int_0^L A(z) \sin \left( \frac{i\pi z}{L} \right) dz \quad (2a)$$

$$\sum_{j=1}^n c_{ij} q_{\beta j} + \sum_{j=1}^n d_{ij} q_{vj} = 0 \quad (2b)$$

where the coefficients are

$$a_{ij} = \int_0^L \left[ EI_x(z) \left( \frac{i\pi}{L} \right)^4 + \frac{GJ(z)}{R^2} \left( \frac{i\pi}{L} \right)^2 \right] \sin \left( \frac{i\pi z}{L} \right) \sin \left( \frac{j\pi z}{L} \right) dz + \sum_{k=1}^{Nn} k_k \sin \left( \frac{i\pi z_k}{L} \right) \sin \left( \frac{j\pi z_k}{L} \right) \quad (3a)$$

$$b_{ij} = \frac{1}{R} \left( \frac{i\pi}{L} \right)^2 \int_0^L (EI_x(z) + GJ(z)) \sin \left( \frac{i\pi z}{L} \right) \sin \left( \frac{j\pi z}{L} \right) dz \quad (3b)$$

$$c_{ij} = \int_0^L \left[ \frac{EI_x(z)}{R^2} + GJ(z) \right] \sin \left( \frac{i\pi z}{L} \right) \sin \left( \frac{j\pi z}{L} \right) dz + \sum_{k=1}^{Nn} k_k \sin \left( \frac{i\pi z_k}{L} \right) \sin \left( \frac{j\pi z_k}{L} \right) \quad (3c)$$

$$d_{ij} = \frac{1}{R} \left( \frac{i\pi}{L} \right)^2 \int_0^L (EI_x(z) + GJ(z)) \sin \left( \frac{i\pi z}{L} \right) \sin \left( \frac{j\pi z}{L} \right) dz \quad (3d)$$

The computational effort of the coefficients depends on the variables  $A(z)$ ,  $I_x(z)$  and  $J(z)$ . For ease of illustration, consider  $Q$  as a line integral of a function  $f(z)$  multiplied by two mode shapes over the path of the curved beam length:

$$Q = \int_0^L f(z) \sin \left( \frac{i\pi z}{L} \right) \sin \left( \frac{j\pi z}{L} \right) dz \quad (4a)$$

It is clear from Eq. (4) that  $f(z)$  needs to be constant in order to fully enjoy the advantage of computational efficiency by adopting orthogonal mode shape functions. Under such a circumstance,  $Q$  is given by

$$Q = \begin{cases} \frac{fL}{2}, & \text{when } i = j \\ 0, & \text{when } i \neq j \end{cases} \quad (4b)$$

If  $f(z)$  is symmetric with respect to the mid-span of the curved beam, partial advantage can be retained and  $Q$  is given by

$$Q = \begin{cases} \int_0^L f(z) \sin \left( \frac{i\pi z}{L} \right) \sin \left( \frac{j\pi z}{L} \right) dz, & \text{when } |i-j| \text{ is even} \\ 0, & \text{when } |i-j| \text{ is odd} \end{cases} \quad (4c)$$

For other functions, however, such advantage is completely lost. Once the coefficients are obtained, the generalized coordinates  $q_{vi}$  and  $q_{\beta i}$  can be computed by using a  $2n \times 2n$  matrix manipulation.

### III. RESULTS AND DISCUSSION

In this section, the accuracy of the solution presented in this paper is first examined against the results generated using a commercial finite element (FE) software. The cases of both homogeneous and inhomogeneous curved beams are considered and examined. Then, a parametric study on a homogeneous curved bridge considering different cross-sectional properties is put forward to study the effect of tidal variations on the bridge.

#### A. Numerical Verification of Homogeneous Curved Bridge

In order to examine the accuracy of the proposed analytical solution presented here for a floating curved pontoon bridge, a homogeneous curved beam resting over

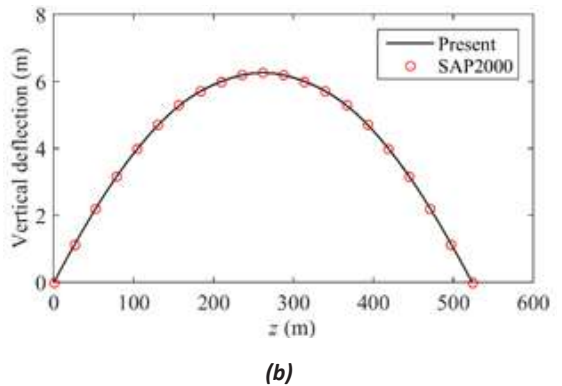
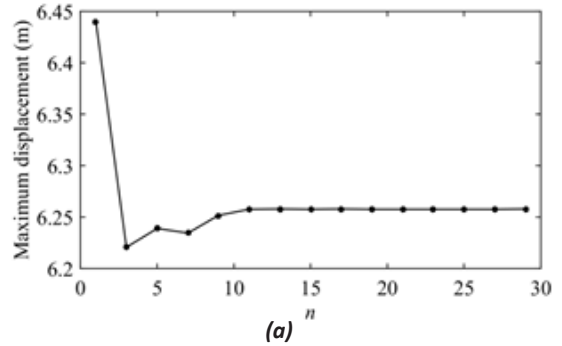
four spring supports is first considered. The properties of curved pontoon bridge are listed in Table 1. The computation of the present solution is conducted using Matlab. Figure 3a shows the convergence of the solution in terms of the maximum vertical displacement. As can be seen, the results converge fast as the number of modes involved in the computation exceeds 5. Figure 3b shows the vertical displacement of the curved pontoon bridge generated by the present solution. Also presented in this figure are the results obtained by the commercial FE software SAP2000 (Computers & Structures, 2016). Note that in the study highlighted in Fig. 3b, the bridge pontoons are not subjected to buoyancy at the initial stage. In other words,  $H_e$  in Eq. (1a) is assumed to be zero. In practical situations, however, a floating bridge is normally designed such that there is virtually zero or negligible relative vertical settlement between the pontoons and the end supports. This requires  $H_e$  of each pontoon to be evaluated. Figure 4 shows the deflection of the same curved beam but with  $H_e$  pre-calculated to ensure that the final displacements at the pontoon supports are zero. Table 2 lists the required  $H_e$  for the four pontoons. As can be seen from Figs. 3b and 4, an excellent agreement between the present approach and the FE results is found, thereby validating the accuracy of the present analytical solution.

**Table 1. Curved bridge parameters**

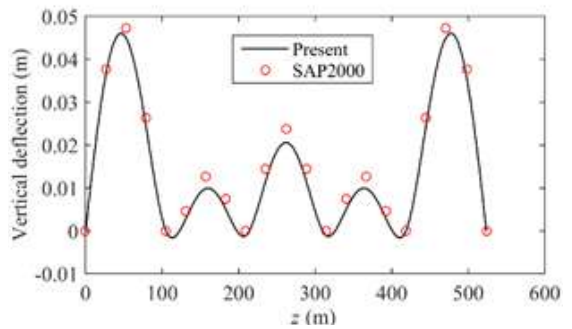
Parameter	Value	Parameter	Value
$L$	523.6 m	$I_x$	50 m <sup>4</sup>
$R$	500 m	$J$	130 m <sup>4</sup>
$\rho A$	58671 kg/m	$\nu$	0.3
$E$	2×10 <sup>11</sup> N/m <sup>2</sup>	$k_{y\nu}$	1.04×10 <sup>7</sup> N/m

**Table 2. Pontoon draft and initial buoyancy**

Pontoon no.	$H_e$	Initial buoyancy
1	6.23 m	68112.7 kN
2	5.36 m	58660.0 kN
3	5.36 m	58660.0 kN
4	6.23 m	68112.7 kN



**Figure 3. Numerical verification: (a) convergence and (b) vertical displacement of homogeneous curved bridge**



**Figure 4. Vertical displacement of curved bridge**

**B. Numerical Verification of Inhomogeneous Curved Bridge**

The accuracy of the proposed analytical solution for a floating curved pontoon bridge with inhomogeneous bridge section is next examined. For ease of computation and comparison against SAP2000, it is assumed here that

the  $I_x$  of the bridge section remains uniform within the same span but exhibits a sudden change in different spans. Figure 5 shows the piece-wise variation of the bridge  $I_x$  throughout the entire length. Note that all the other parameters are the same as those listed in Table 1.

**Figure 5. Inhomogeneous symmetric curved bridge**

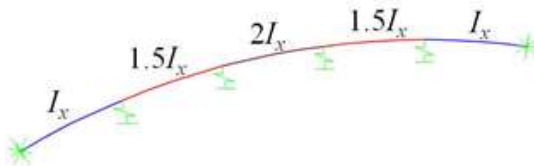
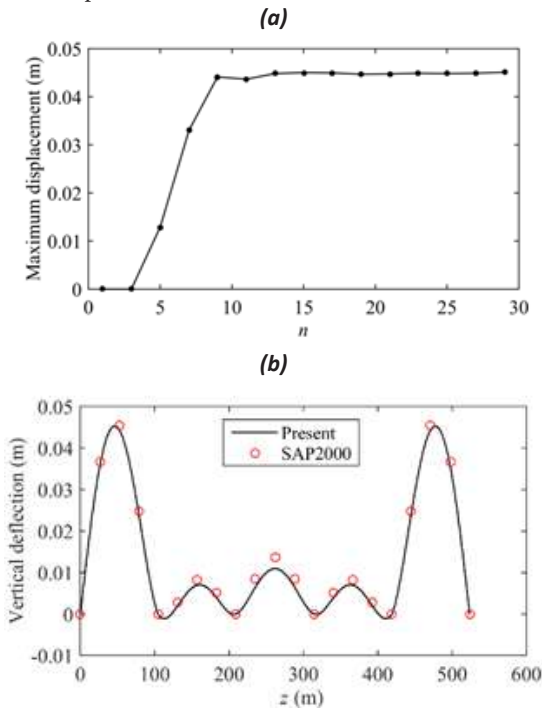


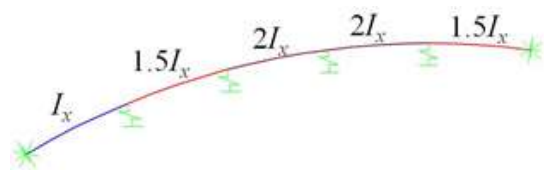
Figure 6a shows the convergence of the present solution in terms of the maximum displacement of the inhomogeneous curved bridge with respect to the number of modes included in the computation. Similar to the case of a homogeneous curved bridge, the proposed solution converges fast in view that satisfactory convergence is achieved with  $n > 10$ . Figure 6b presents the deflection of the curved bridge. As can be seen, the present solution matches well with the FE results.



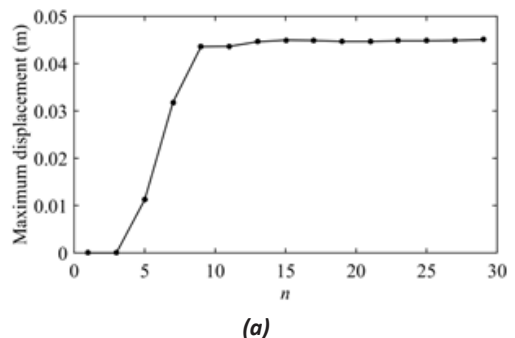
**Figure 6. Numerical verification: (a) convergence and (b) vertical displacement of inhomogeneous symmetric curved bridge**

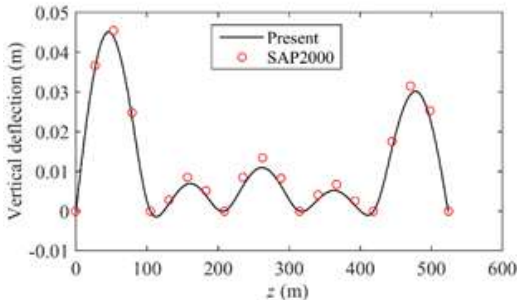
The accuracy of the present solution to an inhomogeneous non-symmetric curved bridge is next examined. Figure 7 shows the piece-wise variation of the bridge superstructure  $I_x$  along its entire length. Unlike homogeneous or inhomogeneous symmetric curved bridges, the use of orthogonal mode trial functions for an inhomogeneous non-symmetric curved bridge does not lead to direct reduction in computational efforts. In other words, the evaluation of the coefficients  $a_{ij}$ ,  $b_{ij}$ ,  $c_{ij}$  and  $d_{ij}$  needs to be carried out according to Eq. (4a). Thus, the efficiency of the solution depends largely on the number of modes that are required in the computation.

The convergence of the analytical solution in terms of the maximum displacement of the inhomogeneous non-symmetric curved bridge with respect to the number of modes included is shown in Fig. 8a. Fortunately, the proposed solution exhibits a fast convergence rate similar to the cases of homogeneous and inhomogeneous symmetric curved bridges. Figure 8b presents the deflection of the curved bridge predicted by the present method and SAP2000. As can be seen, the present solution matches well with the FE results. The CPU time reported by Matlab for the abovementioned three cases is listed in Table 3. Clearly, accurate results for all the three cases studied can be obtained within 5 s. Note that the test is performed on a desktop PC with Intel Core i7-2600 and 16 GB memory. In view of this, it may be concluded that the developed analytical solution is able to offer accurate prediction of the curved bridge displacements efficiently.



**Figure 7. Inhomogeneous non-symmetric curved bridge**





(b)

Figure 8. Numerical verification: (a) convergence and (b) vertical displacement of inhomogeneous non-symmetric curved bridge

Table 3. Computational cost

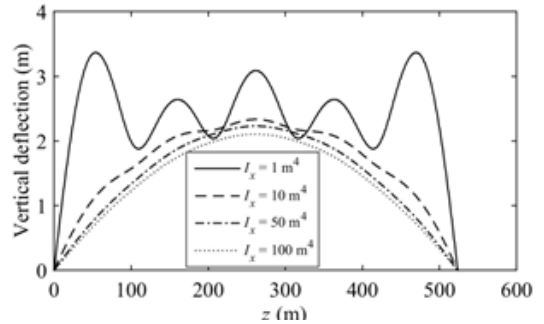
Case	No. of modes	CPU time
Homogeneous bridge	30	0.004 s
Inhomogeneous symmetric bridge	30	1.804 s
Inhomogeneous non-symmetric bridge	30	3.157 s

C. Effect of Tidal Variations on Homogeneous Curved Bridge

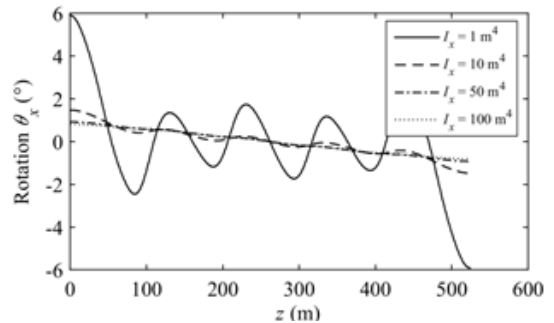
The effect of tide induced water surface elevation is next investigated. Figure 9 shows the vertical displacement and torsional deformation of the bridge when it is subjected to a 2 m low tide. Note that the range of the out-of-plane stiffness of the curved bridge is practically selected based on the sectional properties of the Norwegian Bergsøysund bridge.

It is observed from Fig. 9 that the vertical displacement and rotation angle of the bridge start to converge when the out-of-plane second moment of inertia exceeds 10m4.

When the bridge stiffness is too low ( $I_x = 1m^4$ ), the bridge spans between two adjacent pontoons exhibit noticeable deflections due to the self-weight of the bridge. Such magnitude is definitely not acceptable as it will not only hinder the serviceability of the bridge but may also lead to rupture of the superstructure and the bridge deck.



(a)



(b)

Figure 9. Homogeneous curved bridge subjected to tidal variations: (a) vertical deflection and (b) out-of-plane rotation

IV. CONCLUSION

Presented herein is an analytical approach to study the effect of

tide induced sea surface elevation on a curved floating pontoon bridge. Analytical solution for the out-of-plane responses of the bridge under tidal effect was derived using trigonometric trial functions. The solution was compared with numerical results generated using the commercial finite element software SAP2000. Excellent agreement between the results was found. Furthermore, this analytical approach was shown to converge fast for both homogeneous and inhomogeneous curved bridges. Therefore, it may be concluded that the developed solution is both accurate and efficient.

On the study of the out-of-plane response of a homogeneous curved pontoon bridge under a 2 m low tide, it is found that the second moment of inertia for this particular case

needs to be at least 10 m4. For  $I_x$  in the range of 10 m4 to 100 m4, there appears to be no significant change in the magnitude of the bridge deformation. It is recommended that further study be carried out to investigate the resultant stresses in the curved bridge. The optimal bridge section shall fulfil both the strength and serviceability requirements and at the same time resulting in an economical design.

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# NUMERICAL SIMULATION OF DEBONDING OF CFRP STRENGTHENED STEEL BEAM

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**Abstract** - Carbon Fiber Reinforced Polymer (CFRP) is an advanced engineering material introduced to aerospace industry, recently. Later, the applications of CFRP extended to other field as well. In Civil Engineering, CFRP is popular in retrofitting of damaged and deteriorated structures. Although the material has been successfully applied to concrete structures, applications in steel structures have been limited due to some drawbacks. One of such drawbacks is debonding of CFRP. In an effort to identify the factors affecting debonding, this study explored how the properties of adhesive could affect debonding.

Non-linear finite element analysis was carried out for a 3D model of steel I girder subjected to four point bending. The model was validated using the experimental results available in the literature. CFRP laminate was attached to the bottom of the flange using three different types of adhesives having different material properties.

The results of the numerical simulation showed that both the increment in load carrying capacity and the failure mode is affected by the properties of the adhesive significantly. As the shear strength and the elastic modulus of the adhesive increases, a considerable increase in the load carrying capacity is observed. However, the increment in load carrying capacity with respect to the increment in elastic modulus seems to become less significant as the elastic modulus increases. For example the increment in load carrying capacity per unit increment of elastic modulus between the first two adhesives is 3.7 kN while the same between the second and third adhesives is 0.21 kN. Also, the failure mode is found to be switched from below load point debonding (failure of the bond between the CFRP and adhesive) to below load point splitting (failure of CFRP plate in transverse direction)

Therefore, it can be concluded that when designing a CFRP strengthening system for structural steel, considerable attention must be given to the adhesive properties as well

**Keywords** - CFRP, Steel, Finite Element Analysis

## I. INTRODUCTION

In most of the cases, retrofitting of old structures is considered as the most feasible solution comparing to replacement of those old structures with new structures. Therefore, retrofitting of structures have gained sufficient attention since long in the construction industry. Among the retrofitting techniques in practice such as addition of steel plates or supports or post tensioning of parts, CFRP can be introduced as a relatively new technique. CFRP has found successful application as a retrofitting technique due to its light weight, corrosion resistance and improved fatigue properties.

CFRP, initially introduced to the aerospace industry and later extended its application in the construction industry, is a composite material consists of carbon fibers embedded in a polymer resin. As a result, CFRP behaves as an orthotropic material having different properties in longitudinal and transverse directions. Currently, CFRP can be found in a wide range of elastic moduli values of which the highest value can be above 400 GPa. Due to these remarkable properties, CFRP has been widely employed in retrofitting of concrete structures in most of the countries in the world as well as in Sri Lanka (Fernando, 2011).

However, usage of CFRP in retrofitting of steel structures has been limited due to some drawbacks out of which debonding has become a major concern. However, considerable use of steel can be found in the construction



industry of Sri Lanka (Chandrasiri & Jayasingha, 2005). Therefore, it is important to check for the provisions of using this advanced technique of retrofitting for the steel structures in Sri Lanka.

Debonding between steel and adhesive and also between CFRP and adhesive has been identified as a major drawback of CFRP (Narmashiri et al, 2010). Environmental temperature, humidity level and surface preparation have been identified as the factors affecting bonding of CFRP to steel (Abeygunasekara et al, 2014). Even though several studies have focused on the improvement of load carrying capacity due to CFRP, only a limited number of studies have been dedicated to study the causes for debonding (Kamruzzaman et al, 2014). Therefore, this study focuses on the effect of adhesive properties on debonding of CFRP and steel.

## II.METHODOLOGY

In order to study the effect of adhesive properties on the performance of CFRP strengthened steel I girder, non-linear finite element analysis was carried out in ANSYS 14.5. A 3D model of a steel I girder subjected to four point bending was considered in the analysis.

The dimensions and the material properties of the steel I girder subjected to the analysis were given in Table 1. Pure penalty method was used as the contact algorithm.

Behaviour of steel was modelled using Bi-linear stress-strain relationship. In the plastic region, tangent modulus was taken as 90 GPa. 20 node brick element and 10 node tetrahedral elements were employed for steel I-section.

CFRP plate of thickness 1.2 mm and width 50 mm was attached to the bottom of the steel flange. Length of CFRP plate was 1500mm. the orthotropic nature of CFRP laminates was taken in to account by using an elastic modulus of 160,000 MPa in longitudinal direction and 10,000 MPa in transverse direction Namashri et al. (2010). CFRP laminate was assumed to possess linear stress strain relationship and was modelled using 8 node shell element.

Three different adhesives with the properties given in Table 2 were considered in the analysis. Adhesive thickness was taken as 1 mm.

Further, the adhesive was assumed to possess non-linear material behaviour. Interface elements following bi-linear slip model was used in the contact region. Failure was identified at the point where the internal stresses exceeds the respective strength values.

**Table 1 Dimensions and material properties of steel I section**

Steel I-section dimension (mm)				E-modulus (N/mm <sup>2</sup> ) Mean value	Stress (N/mm <sup>2</sup> )		Strain	
Width	Height	Flange tk.	Web tk.		Yielding (F <sub>y</sub> )	Ultimate (F <sub>u</sub> )	Yielding (ε <sub>y</sub> )%	Ultimate (ε <sub>u</sub> )%
100	150	10	6.6	200,000	250	370	0.12	13.5

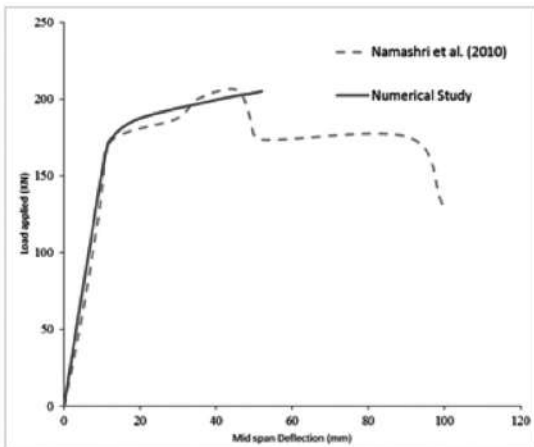
**Table 2 Properties of adhesives**

Adhesive type	E-modulus N/mm <sup>2</sup>	Tensile strength N/mm <sup>2</sup>	Shear strength N/mm <sup>2</sup>	Strain at break %
Sikadur	4500	32	20	0.9
TvfoMB	1230	45.8	19	1.88
Carbon epoxy	142,000	100	55	1.77

### III.RESULTS & DISCUSSION

In order to verify the numerical model created, the results obtained from the model were checked against the experimental results presented by Narmashiri et al (2010). To be compatible with the experimental conditions, a steel I girder of depth 150 mm and width 100 mm is considered with 1500 mm long CFRP plate attached to the bottom flange at the center of the beam. An adhesive with an elastic modulus of 9600 MPa (Narmashiri et al, 2010) was used to attach the CFRP plate to steel.

Comparison between the load vs deflection curves obtained from the numerical analysis in this study and from the experimental analysis in the study done by Narmashiri et al (2010) is given in Figure 2.



**Figure 1: Verification of the numerical model**

It can be seen from the figure that both the curves are in good agreement with each other especially in the elastic region. In their study, Narmashiri et al reported the load bearing capacity as 206.24 kN at which the splitting of CFRP started below the load point.

In our study, this value is found to be 201 kN which deviates only by 2.6% from the value obtained by Narmashiri et al (2010). This difference could be attributed to the experimental errors such as energy losses in strain gauges. Therefore, the numerical model developed in this study can be considered as an accurate model.

After verifying the model, analysis was carried out to see the effect of adhesive properties on the retrofitting performance of CFRP. Three different adhesives with the properties given in Table 2 were used for the analysis. All

the other parameters except the material properties of adhesive were kept the same in all the cases of analysis.

Different types of failure modes were observed during the analysis. In CFRP laminates, fibers are oriented in one direction (longitudinal direction). Therefore, the laminate is stronger in one direction and weaker in the transverse direction.

As a result, CFRP laminates tend to split and this failure is called “below load splitting” and has been denoted as BL-S in this paper. Another mode of failure observed is due to the debonding of epoxy. When the shear stress of epoxy exceeds the shear capacity, this mode of failure can be observed. This is called below the load debonding and denoted by BL-D in this paper. In addition, end debonding which is a result of higher interfacial stresses at the tip of the CFRP and side debonding which is a result of poor bonding has been identified as other modes of failure.

The load carrying capacities obtained for different type of adhesives along with the failure modes observed are reported in Table 3. It can be seen from the results in Table 3 that as the Elastic modulus of adhesive increases, the load carrying capacity of the beam has also been increased. However, the increment in load carrying capacity with respect to the increment in elastic modulus seems to become less significant as the elastic modulus increases.

For example, the increment in load carrying capacity per unit increment of elastic modulus between the first two adhesives is 3.7 kN while the same between the second and third adhesives is 0.21 kN.

It was also observed from the results that the failure pattern of the beam is also affected by the properties of adhesive. For the first two adhesives in which the elastic modulus and the shear strength is considerably lower than the third adhesive, the failure pattern observed is the debonding of CFRP below the load points (BL-D). This is a result of higher shear stress in the adhesive which exceeds the shear capacity of the adhesive.

A snapshot showing the stress levels at this failure is shown in Figure 2. For the third adhesive having a high elastic modulus, the failure occurs due to splitting of CFRP below the load point (BL-S). This is attributed to the fact that the elastic modulus in the transverse direction of CFRP is lower than the elastic modulus of the adhesive. A snapshot showing the stress levels at this failure is shown in Figure 3.

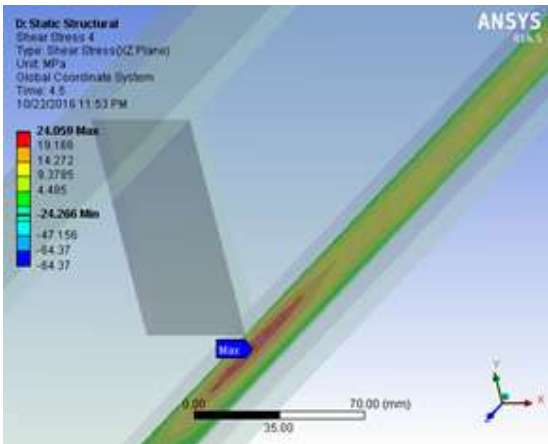


Figure 2: Stress levels at the failure for “BL-D

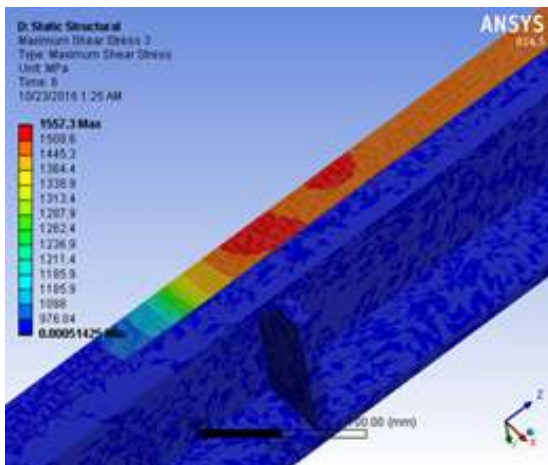


Figure 3: Stress levels at the failure for “BL-S

The load deflection curves of beam obtained for the three cases are given in Figure 4. It can be seen from the figure that in the elastic region, all three adhesives show the same behaviour. However, in the plastic region, clear difference can be observed in the load-displacement behaviour.

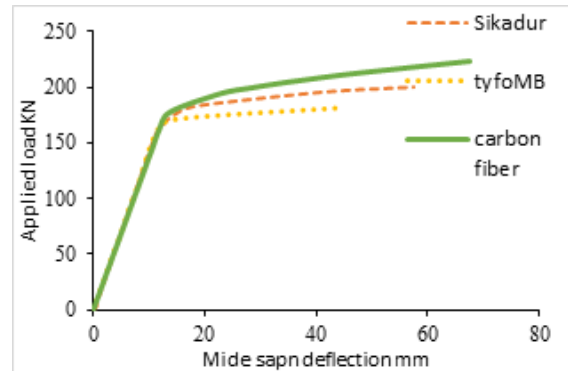


Figure 4: Load-displacement curves

#### IV. CONCLUSION

The results obtained in this study, through a non-linear finite element analysis of a steel I beam strengthened with CFRP plate attached to the bottom flange, reveal that the material properties of adhesive not only affect the load carrying capacity of the beam, but also affect the failure mode. As the elastic modulus of the adhesive increases, the failure mode was found to switch from debonding to splitting of CFRP below the loading point. Also, it can be seen from the results that increment in load carrying capacity due to a unit increment in elastic modulus or

Table 3: Load carrying capacities and failure modes for different adhesives

Epoxy	Failure mode	Max. Shear stress (MPa)	Load carrying capacity (kN)	Mid – span deflection (mm)
TyfoMB	BL-D	20.2	182.35	45.3
Sikadura	BL-D	32.12	194.4	57.34
Carbon epoxy	BL-S	55.58	223.96	67.6

shear strength of adhesive decreases as the elastic modulus or shear strength increases.

This paper focused only on the effect of material properties on debonding failure of CFRP strengthened steel beam. In addition, factors such as humidity and environmental temperature could also play a vital role in debonding. Therefore, it is worth studying the effect of those factors as well to identify the suitability of applying CFRP as a retrofitting technique to Sri Lankan conditions. This will be helpful in understanding why CFRP has not become a popular retrofitting technique in Sri Lanka although it has been widely used in other countries.

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# DETERMINATION OF EXISTING RELATIONSHIP AMONG GRINDABILITY, CHEMICAL COMPOSITION AND PARTICLE SIZE OF RAW MATERIAL MIX AT ARUWAKKALU LIMESTONE.

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**Abstract** - In the production process of the Siam City Cement (Lanka) Ltd, grindability can be mainly effected by the chemical composition of the raw materials, ball mill performance and moisture content. However, currently, in the production process ball mill performance is in its optimum stage and moisture content remains constant at 7%. On account of that the chemical composition and particle size of raw material are the main effecting factors to the lower grindability.

This research study is expected to make a relationship between the grindability and the chemical constituents and particle size of limestone in the raw meal feed. Percentages of SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, Fe<sub>2</sub>O<sub>3</sub>, CaO, MgO, Cl<sup>-</sup>, SO<sub>3</sub>, Na<sub>2</sub>O and K<sub>2</sub>O in limestone are observed for this research. The suitable analysis method (time series and scatter plot analysis) was performed to correlate the chemical constituents with the grindability. The company has been already used a method to check the chemical composition and the grindability hourly of these samples. The XRF (X - ray Fluorescence) analysis is used to check the chemical composition and grindability is checked in the form of residue test of No 212 sieve residue. These chemical analysis and residue test results data of year 2016 were used in data analysis of the research study.

The distribution curves of the variables were analyzed to examine the skewness of the distribution. The time series analysis was carried out to find the best fitting

curve between grindability and the variables. Scatter plot analysis was finally performed and the results show the effect of chemical components such as SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, Fe<sub>2</sub>O<sub>3</sub>, CaO, MgO, SO<sub>3</sub>, Cl<sup>-</sup>, Na<sub>2</sub>O, K<sub>2</sub>O and particle size distribution of raw meal were found to be range correlated with the raw meal grindability.

Standard normal distribution analysis of Percentages of SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, Fe<sub>2</sub>O<sub>3</sub>, CaO and LSF, AR and SR follow the standard normal distribution perfectly. It means it gives unbiased estimation of statistical parameters of the population. Therefore the quality parameter such as LSF, AR and SR lie on the required quality target range upheld by the company. The mathematical relationship among the grindability and variables Silicon Oxide (SiO<sub>2</sub>), Aluminium Oxide (Al<sub>2</sub>O<sub>3</sub>), Ferric Oxide (Fe<sub>2</sub>O<sub>3</sub>), Calcium Oxide (CaO), LSF and SR cannot be given in the form of polynomial, exponential or logarithmic manner, since R<sup>2</sup> values do not equal to the unity.

The most suitable chemical constituents range for improved grindability of raw meal are given based on 68% , 95% and 99% confidence interval. The quality parameters such as Lime Saturation Factor (LSF), Alumina Ratio (AR) and Silica Ratio (SR) also evaluated based on certain error level.

**Keywords** - X-ray Fluorescence, Lime Saturation Factor (LSF), Alumina Ratio (AR), Silica Ratio (SR)

## I. INTRODUCTION

In the cement making process of the Siam City Cement (Lanka) Ltd, it has been identified that there are some raw meal loads that are hard to grind. This low grindability raw meal load causes to get lower output which ultimately results in negative impact to the entire process and sometimes it needs to clear the ball mill manually. It takes a big effort to clear the ball mill and needs to stop the whole production line. In this case the Siam city Cement (Lanka) Ltd still hasn't developed any method to pre-identify the raw meal loads by its grindability.

The production rate and ball mill efficiency getting low when the low grindability raw meal load is fed into the ball mill. During a situation like this, a sample from the low grindability raw meal load is taken to the testing laboratory and check the grindability of the sample by a lab scale ball mill in order to identify whether the problem has occurred due to ball mill defect or change in chemical composition of the raw meal load. However for checking the grindability of a sample takes about two days. Because of that it's not possible to check the grindability of every limestone load in laboratory. At the time when a sample taken to the grindability test and its results release, that load is already fed to the process. On account of these reasons Siam City Cement (Lanka) Ltd emphasized the developing a method to optimize the grindability of raw meal with its chemical composition.

In the cement making process of the Siam City Cement (Lanka) Ltd, there is a facility to check the chemical composition of a limestone sample within 30 minutes in laboratory. Therefore the company has taken action to check the chemical composition of limestone for every four hours period for the crusher outputs and hourly check for the blending cyclone feed (i.e., ball mill output).

Grindability can be mainly effected by the chemical composition of the raw materials or ball mill performance. Chemical composition, moisture content, particle size can be identified as effecting factors of raw material for the grindability. In this case ball mill performance is in its optimum stage and moisture content remains constant at 7%. Because of that the chemical and physical factors of raw material are the mainly effecting factors to the low grindability (Kural and Ozsoy, 2004).

Hence in this research study, it is expected to make a relationship between the grindability and the chemical composition percentages and particle size of limestone.

Percentages of  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{Fe}_2\text{O}_3$ ,  $\text{CaO}$ ,  $\text{MgO}$ ,  $\text{Cl}^-$ ,  $\text{SO}_3$ ,  $\text{Na}_2\text{O}$  and  $\text{K}_2\text{O}$  in limestone are observed for this research study. The suitable analysis was performed to correlate the chemical constituents with its grindability.

## II. METHODOLOGY

The analysis was carried out based on the company recorded data of entire year 2016. Nevertheless three samples were collected hourly using the raw meal auto sampler in the ball meal output for us to get familiarize with the operation procedure of XRF(X - ray Fluorescence) analyser. Furthermore sample size was reduced by coning and quartering in to 200g.

The size reduced samples were heated on the hot plate till particles show considerable low cohesion (until it reaches 7% moisture content). The weight of 200g of the sample was fed to the disc mill and operated for 60 seconds. The disc mill output was used to prepare the tablets for XRF analyser. The tablet was prepared by the pressed powder method. These tablets then used as an input for the XRF analyser and the chemical composition results were shown with in few seconds. Then the results were recorded on the relevant databases.

Research study has been carried out based on chemical analysis and raw meal residue test data of the year 2016. It consist hourly records of chemical composition and the residue test results of the raw meal. These data were subjected to standard normal distribution analysis, Pearson coefficient of correlation analysis, time series analysis and scatter plot analysis.

## III. RESULTS AND DISCUSSION

The results of distribution analysis, time series analysis and scatter plot analysis of the chemical constituent percentages, particle size distribution and No 212 sieve residue values of hourly recorded data of entire year 2016 are described briefly.

### A. Standard Normal Distribution

Standard normal distribution analysis is performed for  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{Fe}_2\text{O}_3$ ,  $\text{CaO}$ , LSF, SR, AR and No 212 sieve residue. The main reason for the analysis of normal distribution is to check the accuracy of the predicted population parameters, which are required in the following analysis methods.

The statistical parameters of the Silicon Dioxide, Aluminium Oxide, Ferric Oxide, Calcium Oxide, and quality parameters such as Lime Saturation Factor, Silicon Ratio and Alumina Ratio and residue test results of the No 212 sieve residue are summarized in Table 1, Table 2 and Table 3.

**Table 1. Statistical parameters of variables**

variable	$\mu$ (mean)	$\sigma$ (S.D)*	-1<Z<1	-2<Z<2	-3<Z<3
SiO <sub>2</sub> (%)	13.98	0.56	68.49	95.45	99.69
Al <sub>2</sub> O <sub>3</sub> (%)	1.57	0.17	70.79	95.67	99.32
Fe <sub>2</sub> O <sub>3</sub> (%)	2.15	0.29	72.57	95.94	98.90
CaO(%)	44.14	0.60	70.29	95.34	99.34
LSF(%)			67.92	95.52	99.69
SR(%)			69.37	95.34	99.52
AR(%)			68.62	95.59	99.34
No 212 sieve residue(%)	1.92	0.28	67.57	95.28	99.58

**Table 2. Statistical parameters of quality ratios**

variable	LSF	SR	AR
$\mu$ (mean)	99.4	2.57	1.58
$\sigma$ (S.D)*	3.5	0.18	0.17

**Table 3. Skewness values of variables**

variable	Skewness(S <sub>K</sub> )
SiO <sub>2</sub>	0.09
Al <sub>2</sub> O <sub>3</sub>	0.61
Fe <sub>2</sub> O <sub>3</sub>	1.11
CaO	-0.45
LSF	-0.04
SR	-0.15
AR	0
No 212 sieve residue	0.13

\*S.D = Standard Deviation

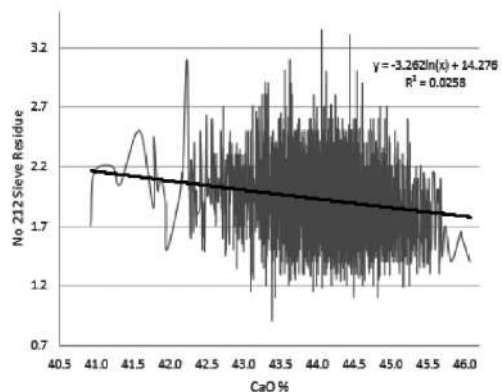
The above Table 3 shows the skewness values of all variables are nearly equal to zero. This implies these chemical parameters follow the perfect standard normal distribution. Furthermore, it shows there is no any significant variation of these chemical parameters in the

raw meal over the observed year of 2016, which ultimately gives smooth operation and constant value for the quality parameters. The Lime Saturation Factor (LSF) is used for kiln feed control. Consequently, the larger variation of the LSF results in, makes it difficult to burn raw meal, tends to cause unsoundness of cement and causes slow setting with high early strength (Almeida, Rocha and Teixeira, 2004). But the results show there is no any significant variation in LSF over the observed time period and results show most of the data are lie on the company's threshold value range of LSF 96-106.

The large variation in Silicon Ratio and Alumina Ratio in the clinker can be an indication of poor uniformity in the kiln feed (Bye, 1983). These variation may result in harder to burning and high fuel consumption, deteriorate the kiln lining and tends to cause unsoundness of cement (Hassaan, 2001), (Shih, Chang and Chiang, 2003). Since the skewness values of the SR and AR are nearly zero, it has no fluctuations over the time period.

**B. Time Series Analysis**

The time series analysis results show the mathematical trend line relationship among No 212 sieve residue, chemical constituents and quality ratios such as LSF, SR and AR and particle size distribution of raw meal feed. The relationship between CaO% of the raw meal data obtained and respective No 212 sieve residue is shown in the Figure 1. The overall relationship (solid line) shows there is a decrease in residue with the increase in the CaO%. It means grindability increases with the increase of CaO%.



**Figure 1. Graph of CaO% vs. No 212 sieve residue**

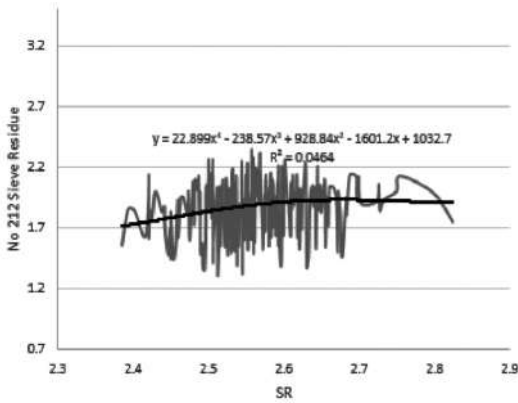


Figure 2. Graph of SR vs. No 212 sieve residue

The relationship between SR of the raw meal and respective No 212 sieve residue is shown in the Figure 2. The overall relationship (fourth order polynomial) shows there is an increase in residue with the increase in the SR. It means grindability reduces with the increase of SR.

The fourth order polynomial trend line between SiO<sub>2</sub>% present in raw meal and No 212 sieve residue shown in the figure 3 has no any significant variation over the SiO<sub>2</sub>% values.

The Al<sub>2</sub>O<sub>3</sub>% present in the raw meal and the respective No 212 sieve residue values show significant reduction of residue values in the higher Al<sub>2</sub>O<sub>3</sub>% content. The Figure 4 shows the fourth order polynomial relationship between Al<sub>2</sub>O<sub>3</sub>% and No 212 sieve residue values.

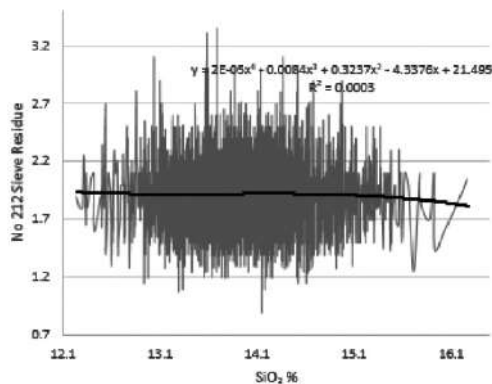


Figure 3. Graph of SiO<sub>2</sub>% vs. No 212 sieve residue

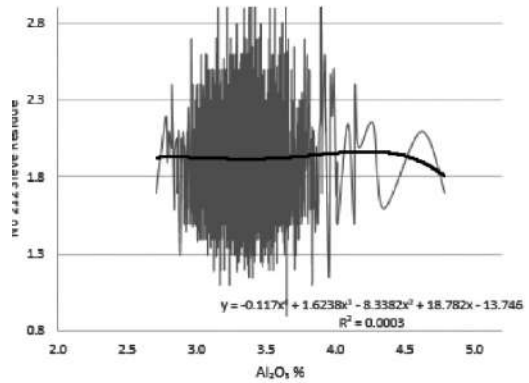


Figure 4. Graph of Al<sub>2</sub>O<sub>3</sub>% vs. No 212 sieve residue

C.Scatter Plot Analysis

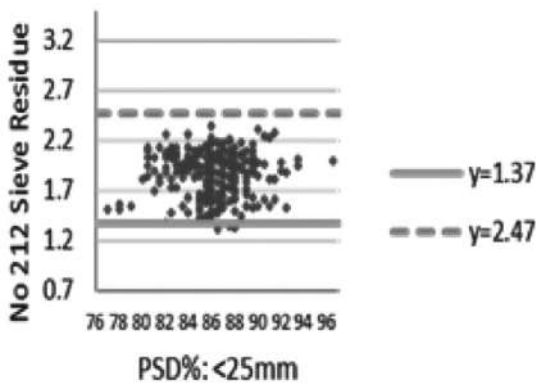
Scatter plot analysis is performed for percentages of chemical constituents, particle size distribution (PSD) < 25mm, PSD > 25mm and No 212 Sieve Residue of the raw meal under different confidence interval such as 68%, 95% and 99%.

The 68%, 95% and 99% confidence interval value range of the variables are calculated based on (μ-σ, μ+σ), (μ-2σ, μ+2σ) and (μ-3σ, μ+3σ) values of the each variable respectively. Where μ is the mean and σ is the standard deviation of the variable. The Table 4 shows the confidence interval value range of the mentioned variables. According to above values, the selection of SiO<sub>2</sub>%, Al<sub>2</sub>O<sub>3</sub>%, Fe<sub>2</sub>O<sub>3</sub>% and CaO% based on 68%, 95% and 99% confidence interval will result in a No 212 residue in between 1.7 - 2.2, 1.37 - 2.47 and 1.09 - 2.75, respectively.

Table 4. Confidence interval values of variables

Item (%)	68% Confidence Interval		95% Confidence Interval		99% Confidence Interval	
	μ-σ	μ+σ	μ-2σ	μ+2σ	μ-3σ	μ+3σ
CaO	43.55	44.74	42.95	45.34	42.35	45.93
SiO <sub>2</sub>	13.42	14.54	12.86	15.1	12.3	15.66
Fe <sub>2</sub> O <sub>3</sub>	1.86	2.45	1.56	2.74	1.27	3.04
Al <sub>2</sub> O <sub>3</sub>	3.15	3.51	2.97	3.69	2.79	3.87





No 212 sieve residue	1.7	2.2	1.37	2.47	1.09	2.75
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Figure 5. Graph of PSD% < 25 mm vs. No 212 sieve residue

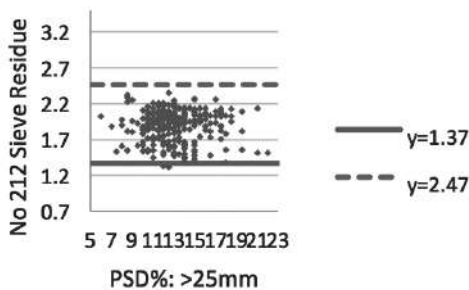


Figure 6. Graph of PSD% > 25 mm vs. No 212 sieve residue

The Figure 5 and Figure 6 show the scatter plots of PSD < 25 mm and PSD > 25 mm in the raw meal and respective No 212 sieve residue values. Graphs show all the values of PSD < 25mm and PSD > 25mm are result in residue in between 1.7 and 2.2. It implies there is no any significant effect from the particle size distribution to the raw meal grindability.

#### IV. CONCLUSIONS

The conclusions based on the results of standard normal distribution analysis;

- Percentages of SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, Fe<sub>2</sub>O<sub>3</sub>, CaO and LSF, AR and SR follow the standard normal distribution,

perfectly. It means it gives unbiased estimation of statistical parameters of the population. Therefore the quality parameter such as LSF, AR and SR lie on the required quality target range upheld by the company.

#### The conclusions based on the results of the time series analysis;

- The mathematical relationship among the grindability and variables Silicon Oxide (SiO<sub>2</sub>), Aluminium Oxide (Al<sub>2</sub>O<sub>3</sub>), Ferric Oxide (Fe<sub>2</sub>O<sub>3</sub>) Calcium Oxide (CaO), LSF and SR cannot be given in the form of polynomial, exponential or logarithmic manner. Since R<sup>2</sup> values do not equal to the unity.

#### The conclusions based on the results of the scatter plot analysis;

- The 68% confidence interval has the lowest value range for No 212 sieve residue (easy for grinding), but it comprised with the highest error.
- The 95% confidence interval has the middle value range for No 212 sieve residue (moderate for grinding) but it comprised with the lower error.
- The 99% confidence interval has the highest range for No 212 sieve residue (difficult for grinding) but it comprised with the lowest error.
- Since all the value ranges for particle size <25mm and >25mm are resulted in 68% confidence interval range, particle size does not show any significant impact on grindability.

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# USE OF OZONATION FOR DEGRADATION OF GLYPHOSATE IN POTABLE WATER OF CKDu PREVALENT AREAS

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**Abstract** - Consumption of water contaminated with agrochemicals is implicated to be one of the triggering causes of the Chronic Kidney Disease of unknown etiology (CKDu). Glyphosate, which is commercially available as Roundup<sup>®</sup>, was the widely used herbicide in Sri Lanka until recently hence, it has still been persistent in the environment. Recent studies provide evidences of the presence of Glyphosate in trace levels in urine samples of CKDu patients and also in different water sources in the CKDu prevalent areas containing elevated hardness levels.

Thus, Glyphosate is suspected to be a causal factor for CKDu and its removal, when present in potable water, is a challenging engineering task. Ozonation is recognised to be one of the promising technologies for the degradation of Glyphosate. This study focuses on investigating the effectiveness of Ozonation for degradation of Glyphosate from potable waters and the effect of hardness on the efficiency of Glyphosate degradation by Ozonation. Experiments were conducted with high purity Glyphosate and Roundup<sup>®</sup> in the absence and presence of hardness (1,500 mg/L as CaCO<sub>3</sub>). A 10 L water sample with Glyphosate/Roundup<sup>®</sup> (1 mg/L) was continuously ozonised (200 mg/h) and samples from the reaction solution were analysed for Glyphosate and Amminomethylphosphonic acid (AMPA) using GC/MS and LC/MS.

A rapid decrease in Glyphosate/Roundup<sup>®</sup> concentration was observed within first ten minutes of reaction time. Presence of hardness resulted in slower Glyphosate degradation rate compared to absence of hardness, which could be attributed to formation of Glyphosate-Ca and -Mg complexes hindering direct contact of Ozone with Glyphosate. Degradation rate of Roundup<sup>®</sup>

by Ozonation was slower than high purity Glyphosate, in the absence and presence of hardness. Presence of the surfactant [polyethoxylated tallowamine, (POEA)] in Roundup<sup>®</sup> enhanced the persistence of Glyphosate in water thus causing retardation of Glyphosate degradation by Ozonation. However, AMPA was not detected demonstrating complete degradation of Glyphosate by Ozonation.

In conclusion, it can be inferred that Ozonation is a simple, affordable and promising technique that could be effectively and efficiently used to degrade Glyphosate present in potable water of CKDu prevalent areas.

**Keywords** - CKDu, Glyphosate, Ozonation

## I. INTRODUCTION

Chronic Kidney Disease of unknown etiology (CKDu) is a critical health issue prevailing in some parts of Sri Lanka (e.g. North Central Province) for past two decades. The exact causal factor(s) of CKDu have not yet been identified. Since majority of the reported CKDu victims is from the farming communities and also above age of 40 years, agrochemical contamination of water had been suggested as a main triggering issue of CKDu (Wanigasuriya, 2012).

However, based on the previous studies, possible pathways leading to widespread of CKDu include; (i) direct consumption of food contaminated with pollutants and toxins, (ii) direct ingestion of agro-chemical toxins into body due to careless handling of agro-chemicals and, (iii) prolonged exposure to water contaminated with pollutants and toxins (Dharma-wardana et al., 2014). Among the suggested pathways, prolonged exposure to toxins

through consumption of potable water contaminated with agrochemicals such as pesticides and herbicides has been received major attention in the recent past.

Glyphosate, which is commercially available as Roundup®, was the most widely used herbicide among various agrochemicals being used in the CKDu prevalent areas in Sri Lanka until recently. Glyphosate [N-(phosphonomethyl) glycine] was used as a broad-spectrum systemic herbicide and crop desiccant and known to have a greater efficiency compared to other herbicides due to its higher effectiveness in weed killing and low toxicity to non-target organisms. Preliminary field visits conducted in the CKDu prevalent areas provided evidence that Roundup® is still being used in some of the Chena cultivations despite the prohibition imposed by the Sri Lankan Government on importation and use of Glyphosate since year 2015. Thus, it was found that Glyphosate has still been persistent in the environment (Jayasumana et al., 2015). Recent studies provide evidence of presence of Glyphosate in trace levels in water sources (drinking water, surface water, and groundwater) in the CKDu affected areas that contain elevated hardness levels. In addition, a WHO study has corroborated that the percentage of CKDu subjects having Glyphosate residues in urine samples more than that of the reference threshold level was 3.5% (WHO, 2013).

Glyphosate molecule consists of three major functional groups; phosphonic group, amino group and carboxylic group. The major metabolite of Glyphosate is Aminomethylphosphonic acid (AMPA). Potable waters in CKDu prevalent areas contain high hardness levels (e.g. 1500 mg/L as CaCO<sub>3</sub>) particularly in dry seasons. It has been implicated that Glyphosate has the tendency to form stable and persistent complex compounds with Ca<sup>2+</sup> and Mg<sup>2+</sup> when present in hard water (Thelen et al., 1995). Further, Glyphosate has the ability to capture various metals such as Arsenic, Copper and other nephrotoxic metals and act as a carrier compound to deliver these metals to the human body and organs, eventually causing damages to the kidney and its renal functions (Jayasumana et al., 2014). Glyphosate is the active ingredient in Roundup®. However, Roundup® also contains a major adjuvant surfactant known as polyethoxylated tallowamine, (POEA), introduced as an inert ingredient during Roundup® production process to enhance the bio-efficacy of the herbicide. Presence of POEA with Glyphosate has shown to be cytotoxic (toxic to cells) at doses lower than Glyphosate alone (Mesnage et al., 2013). According to USEPA guidelines, the maximum contamination limit (MCL) allowed in drinking water for

Glyphosate is 0.7 mg/L (EPA, 1995). Therefore, Glyphosate is suspected as a causal factor for CKDu and degradation of Glyphosate, if present in potable waters, is a challenging engineering task.

Ozonation is a powerful oxidation process and known as an effective technique that could be used to degrade Glyphosate present in water (Assalin et al., 2009). Once Ozone is purged into the water, it can dissociate into diatomic oxygen and oxygen radicals due to its instability (Bourgeois et al., 2012). Oxygen radicals are very reactive hence tend to create bonds with the nearest possible components available to form compounds that can escape with ozone (Bourgeois et al., 2012). Ozone would have a rapid reaction with Glyphosate and primarily reacts with the amine group in Glyphosate to produce AMPA (Assalin et al., 2009).

Past studies have reported complete degradation of Glyphosate in the presence of high Ozone concentration where the reaction is said to be irreversible and continued until inorganic phosphate is produced (Jönsson et al., 2013). However, it can be hypothesized that the presence of POEA in Roundup® could hinder the efficiency of Ozonation process as the Ethylene-oxide present in POEA tends to form hydrogen bonds with Glyphosate enhancing the stability of Glyphosate in water (Kuchikata et al., 2001). Also, the presence of high hardness levels in potable waters in CKDu prevalent areas could hinder the Glyphosate degradation process by Ozonation due to possible formation of Glyphosate-Metal complexes. Studies on the effects of POEA and hardness on efficiency of Ozonation process for degradation of Glyphosate have not been reported in the literature. Therefore, this study focused on investigating (1) the suitability of Ozonation for degradation of Glyphosate (high purity) and Roundup® containing POEA when present in potable water with high hardness levels of CKDu prevalent areas, and, (2) the effect of presence of hardness on the efficiency of Glyphosate degradation by Ozonation.

## II. METHODOLOGY

### A. Materials

Glyphosate (PESTANAL®, 98% purity) and Roundup® (360 g/l Glyphosate) were used in all the experiments. Analytical standard of AMPA was purchased from Sigma-Aldrich. Stock solutions of 1000 mg/L were prepared with Glyphosate and Roundup®, respectively, using deionized water (Resistivity <18.2 megohm). Working solutions of 1

mg/L of Glyphosate and 1 mg/L Roundup® were prepared by diluting the respective stock solutions using deionized water.

Experiments were conducted in the absence and presence of hardness. Hardness concentration used was 1,500 mg/L as CaCO<sub>3</sub> to simulate the extreme dry weather conditions, which could occur in the CKDu prevalent areas. Confirmation of hardness levels in water samples were carried according to the EDTA Titrimetric method 2340 C.

**B. Experimental Setup**

Ozonation probe, while continuously releasing Ozone (200 mg/h), was immersed in the 10 L water sample containing Glyphosate or Roundup® in the absence and presence of hardness. During Ozonation, samples from the reaction solution were collected at predetermined time intervals for Glyphosate and AMPA analysis. The pH value of the water was continuously measured using a pH meter. All experiments were conducted under the ambient conditions.

**C. Analysis of Glyphosate and AMPA**

Glyphosate and AMPA concentrations of water samples without hardness were analysed using the Gas

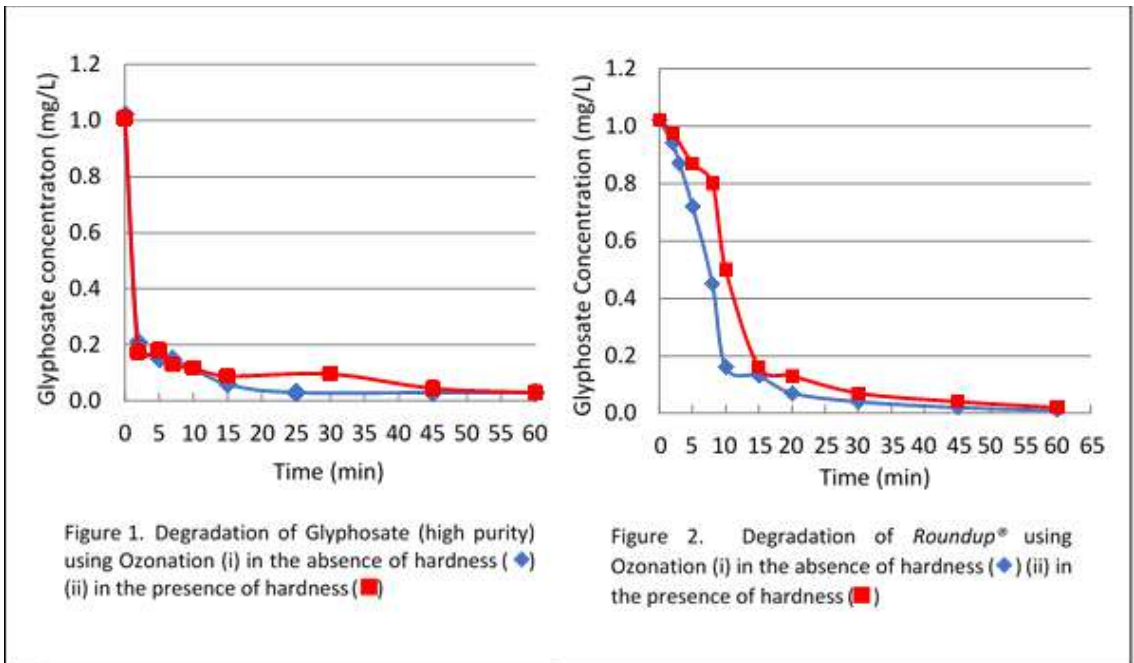
Chromatography/Mass Spectrometry (GC/MS) (Agilent 7890 B GC with 5977 Mass Selective Detector) coupled with a split-less injector and HP 5 MS column. Helium was used as the carrier gas. Samples for GC/MS analyses were derivatized using Trifluoro-acetic anhydride (TFAA) and Trifluoroethanol (TFE) and Ethyl Acetate was used as the organic solvent. Water samples consisted of hardness were analysed using the Liquid Chromatography/Mass Spectrometry (LC/MS) Single Quad (Agilent 1200 Infinity series LC with G1600 series Mass Selective Detector) coupled with Zorbax Eclipse XDB- C18 column. Samples for LC/MS analyses were derivatized using 10 mg/l 9-fluorenylmethyl chloroformate.

**III. RESULTS AND DISCUSSION**

**A. Glyphosate degradation by Ozonation**

Degradation of Glyphosate (high purity) and Roundup® using Ozonation over time is presented in Fig.1 and Fig.2, respectively. A rapid decrease in Glyphosate concentration was observed within first ten minutes of reaction time in all experiments (Fig.1, Fig.2). During Ozonation, variation of the pH in water with Glyphosate or Roundup® ranged from 4.5-4.7 in the absence of hardness and 5.2-5.4 in the presence of hardness.

Based on the literature, amino group is the primary



reaction site of Glyphosate to react with Ozone (Assalin et al., 2009). During Ozonation, oxidation can occur as direct oxidation by Ozone or indirect oxidation by hydroxyl radicals (Gunten, 2003). Thus, Ozone and hydroxyl radicals are known to react with the amino group of Glyphosate to form AMPA (Assalin et al., 2009). However, AMPA was not detected in all the experiments of the present study.

Therefore, it can be suggested that, under all experimental conditions of the present study, complete degradation of Glyphosate had occurred by Ozonation. In other words, the reactions were rapid and irreversible that inorganic phosphate is produced. The findings of this study are consistent with previous-reported research where complete degradation of Glyphosate was achieved in the presence of high Ozone concentration (Jönsson et al., 2013). In addition, Klinger et al., 1998 reported a complete degradation of Glyphosate and accumulation of inorganic phosphate during the Ozonation reaction (Klinger et al., 1998).

### **B. Effect of Hardness on Glyphosate degradation by Ozonation**

During Ozonation, when Glyphosate (high purity) was present in water, 0.95 minutes (in the absence of hardness) and 1.00 minute (in the presence of hardness) were taken to reduce the Glyphosate concentration to 0.7 mg/L, which is the MCL in drinking water specified by USEPA (Fig. 1). When Roundup® was used, Glyphosate concentration in water was reduced to 0.7 mg/L at the end of 5.00 and 7.00 minutes, in the absence and presence of hardness, respectively (Fig.2).

Therefore, slower Glyphosate degradation was observed in the presence of hardness compared to that in the absence of hardness (Figs. 1 and 2) indicating that hardness may be a triggering factor for Glyphosate to be persistent in water. Glyphosate could form stable bonds with Ca<sup>2+</sup> and Mg<sup>2+</sup> when present in hard water (Thelen et al., 1995); Nuclear Magnetic Resonance (NMR) studies have provided evidence of formation of stable bonds of Ca<sup>2+</sup> and Mg<sup>2+</sup> with both phosphonic and carboxylic groups of Glyphosate by replacing H<sup>+</sup> ions in these functional groups (Thelen et al., 1995). These Glyphosate-Ca and -Mg complexes could enhance the persistence of Glyphosate in water. Additionally, interference of Ca<sup>2+</sup> and Mg<sup>2+</sup> ions present in hard water could hinder the direct contact of Ozone with Glyphosate adversely affecting the efficiency of Ozonation process.

### **C. Effect of presence of Surfactants on degradation of Glyphosate by Ozonation**

The results showed that the time of Ozonation required for degradation of Roundup® to reach the MCL is 5-7 times longer than the time required for Glyphosate (high purity) alone to reach the MCL, both in the absence and presence of hardness.

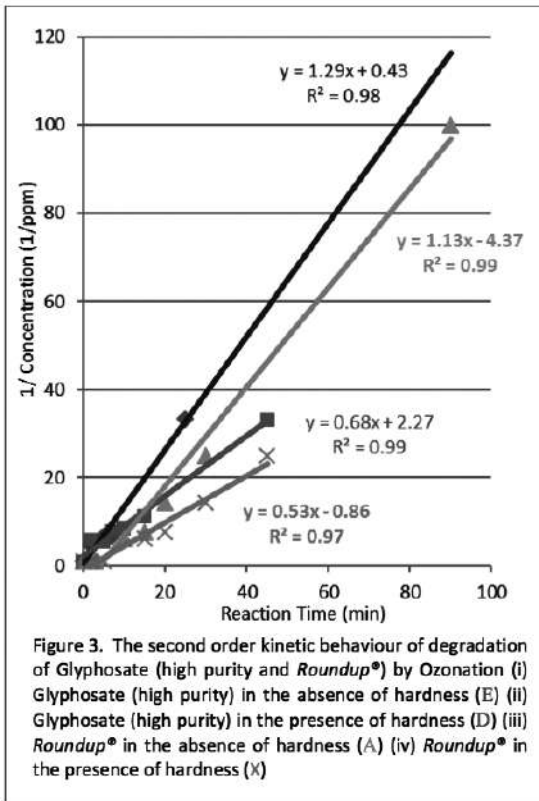
The presence of POEA delayed the Ozonation process indicating the persistence of Glyphosate in water with strong bond formation that hinders the degradation by Ozonation. Ethylene-oxide in POEA is known to form hydrogen bonds with Glyphosate (Kuchikata et al., 2001). Hence, during Ozonation, the oxygen and hydroxyl radicals would first require breaking through the hydrogen bonding in order to reach and react with the Glyphosate molecules. Thus, the presence of POEA would lead to a retardation of Glyphosate degradation by Ozonation, both in the absence and presence of hardness (Fig. 2).

### **D. Rate constant**

Reaction of Ozone with high purity Glyphosate and Roundup®, in the absence and presence of hardness, followed the second order kinetic behaviour. Figure 3 presents the second order kinetic behaviour of high purity Glyphosate and Roundup®, in the absence and presence of hardness. Rate constants obtained for the high purity Glyphosate were 1.29 m<sup>-1</sup> and 0.68 m<sup>-1</sup> in the absence and presence of hardness respectively. As the data clearly demonstrate the rate constant of Glyphosate degradation using Ozonation was slower in the presence of hardness confirming enhanced persistence of Glyphosate due to hardness in water. The rate constants obtained for Roundup® were 1.13 m<sup>-1</sup> and 0.53 m<sup>-1</sup> in the absence and presence of hardness respectively.

Comparison of the rate constants obtained for high purity Glyphosate and for Roundup® in the absence of hardness clearly shows retardation of Glyphosate degradation due to the presence of surfactants in Roundup®. Among the various experimental conditions studied, the slowest rate constant was observed with Roundup® in the presence of hardness.

This observation further confirms the combined antagonistic effect imposed on Glyphosate degradation by Ozonation due to the simultaneous presence of hardness and the surfactants.



## IV. CONCLUSION

This study investigated the suitability of Ozonation for degradation of Glyphosate (high purity and Roundup®) present in potable water of CKDu prevalent areas containing high hardness levels and the effect of hardness on the efficiency of Glyphosate degradation by Ozonation. Glyphosate (high purity) and Roundup® were rapidly degraded by Ozonation to levels lower than the USEPA MCL value (0.7 mg/l) within first ten minutes of the reaction. Presence of hardness resulted in slower Glyphosate degradation rates suggesting enhanced persistence of possible Glyphosate-Ca and -Mg complexes formed in water and interference of Ca<sup>2+</sup> and Mg<sup>2+</sup> ions present in water hindering direct contact of Ozone with Glyphosate.

Degradation rate of Roundup® was slower than that of high purity Glyphosate, both in the absence and presence of hardness. Presence of the major adjuvant surfactant (POEA) in Roundup® enhanced the persistence of Glyphosate in water and formation of hydrogen bonding

of POEA with Glyphosate could lead to a retardation of Glyphosate degradation by Ozonation. In conclusion, it can be inferred that, despite the possible antagonistic effects imposed by presence of hardness and POEA, Ozonation is a simple, affordable and promising technique that could be effectively and efficiently used to degrade Glyphosate present in potable water of CKDu prevalent areas to levels that are of no significance.

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# LOCALLY AVAILABLE LOW-COST PACKING MEDIA FOR ANAEROBIC FILTERS TO TREAT LANDFILL LEACHATE

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**Abstract** - Solid waste generated in urban centres is disposed into sanitary landfills or dumping sites. The generated leachate at dumping sites causes many problems leading to various environmental impacts. Hence, it is decided to conduct this research to find out an economical solution that suits to the country for proper treatment of leachate generated at dump sites. As the major portion of municipal solid waste is biodegradable, anaerobic filters well suit to the leachate treatment. As the packing media used for this treatment is highly expensive, finding readily and locally available, low-cost and efficient packing media is a timely need.

Therefore, the performances of locally available and low-cost organic and inorganic packing media in treating landfill leachate were studied using a laboratory scale experimental set-up consisting of four packed-bed down-flow anaerobic filter columns. The height and diameter of the cylindrical shaped packed bed were 75 cm and 10 cm, respectively.

The first three columns were filled with quartz, saw chips and quarry dust. The fourth column filled by using 25cm height layers of quartz, saw chips and quarry dust respectively. Each column was loaded with landfill leachate. Overall, quarry dust and mixed filter gave higher removal efficiencies than the other media for COD (Chemical Oxygen Demand) and BOD (Biochemical Oxygen Demand).

The removal efficiency of turbidity remained around 90% for a long period of the experimental series in quarry dust filter. Mixed and saw chips filters showed higher turbidity removal percentages initially but decreased with the time. According to the experimental results, it was found that

quarry dust and mixed filter can be used to treat landfill leachate effectively.

**Keywords** - Leachate, Down flow anaerobic filters, COD/ BOD/ Turbidity removal

## I. INTRODUCTION

With the growth of population, the need and wants of the people are increasing day by day. Due to this reason, the solid waste generation has increased throughout the country. Hence, solid waste management is an inevitable term of sustainable development. "Landfill" becomes the most viable and economical method which is used widely in modern world. Leachate is the liquid that generates when degenerating waste of solids in landfills contact with moisture. This causes a serious environmental issues due to substantial amount of organic and inorganic substances in leachate. It has the potential to pollute ground and surface water. Therefore, the leachate should be treated properly.

The main contributor to the generation of landfill leachate is rainfall. The precipitation percolates through the waste and gains dissolved and suspended components from the biodegrading waste due to several physical and chemical reactions. Groundwater inflow, surface water runoff and biological decomposition are the other contributors to leachate generation.

The environmental risks of leachate generation arise from it escaping into the environment around landfills, particularly to watercourses and ground water. These risks can be reduced by treating leachate. Leachate treatment technologies fall in to two basic types, biological and

physical/ chemical. Attached growth technologies, which come under biochemical treatment, have successfully been used for landfill leachate treatment. There are many advantages of attached growth processes over suspended growth processes are lower energy requirements, simpler operation, no bulking problems, less maintenance and better recovery from shock loads.

The removal of BOD, COD and turbidity are affected by attached growth process in waste water treatment. One of the most commonly applied attached growth processes to treat landfill leachate is known as anaerobic filters. However, the application of anaerobic filters has become very expensive due to expensive packing media. Therefore, the study focuses on the attached growth anaerobic down-flow treatment method. A challenge which is ongoing in environmental researchers is to find suitable materials, methods and modifications in the context of low cost landfill leachate treatment.

The aim of this study was to find out the efficiency of several low-cost, locally and readily available materials as packing media in down-flow anaerobic filter columns in treating landfill leachate. The selected materials are quarry dust, quartz and saw chips. The objective of this study is to compare the treatment efficiencies of different materials and to obtain the most efficient packing materials in treating organic and nitrogenous compounds in landfill leachate.

## II. METHODOLOGY

The experimental setup include four anaerobic filter columns, each column have 101 cm height and 10 cm diameter. A sieve and gravel layer (8 cm) placed at the bottom of each column. First three columns were filled with 75 cm height layers of quartz, saw chips and quarry dust respectively. Fourth column was filled by using 25 cm height layers of quartz, saw chips and quarry dust. All the packing media were washed and dried before filling in columns and all the columns were flushed by tap water to remove all readily flushable contaminants from the media.

The leachate collected from Karadiyana dumpsite which is the largest dumpsite in Colombo. This collected leachate was used as the influent for all experiments. Same influent flow rate was supplied for each column by using an overhead tank as shown in figure 1.



Figure 1. Experimental model

Table 1 shows the influent characteristics. The duration of experiment series is 25 days. During this experimental series, influent and effluent were characterized using Biochemical Oxygen Demand, Chemical Oxygen Demand, Turbidity and pH parameters.

Table 1. Influent Characteristics

Characteristics of the influent	Down-flow system
BOD <sub>5</sub> (mg/l)	8.6
COD (mg/l)	1880
Turbidity (NTU)	144
pH	8.01

The removal efficiency of a certain characteristic was calculated by using the following equation  
 Removal Efficiency (%) =  $\left( \frac{I - E}{I} \right) * 100\%$

I - Influent Characteristic

E - Effluent Characteristic

### III. RESULTS AND DISCUSSION

#### A. Removal Efficiency of BOD

The efficiency of removing BOD by each packing media was determined by measuring BOD of the influent and effluent. BOD reduced while flowing through quarry dust and mixed filter columns. Figure 2 shows the variation of the removal efficiency of BOD with time for four different packing media. The removal efficiency of quarry dust and mixed filter were greater than 50% on average, whereas the highest efficiency was shown by the quarry dust filter. It varied between 55.81% and 86.04%. The removal efficiencies of both saw chips and quartz filters were not in a satisfactory state due to higher BOD value in the effluent. According to Coony (1999), adsorption is a very important method for removing contaminants, particularly organic contaminants from wastewater streams. Therefore, adsorption can also be considered as potential removal mechanism of organic materials in the columns with organic packing media. According to test results, it was found that quarry dust and mixed filters can be used to treat BOD in landfill leachate.



Figure 2. Variation of BOD removal efficiency

#### B. Removal Efficiency of COD

The efficiency of removing organic matter by each packing media was determined by measuring COD of influent and effluent of landfill leachate. Figure 3 shows the variation of COD removal efficiency. The average removal efficiency of quarry dust and mixed filters were 72.9% and 63.7% respectively, whereas the highest efficiency (94.68%) was

shown by quarry dust filter column. This could have been caused due to adsorption. The removal efficiencies of both saw chips and quartz filters were not in a satisfactory level. Mixed filter showed improvement in removing COD in first three days, which could be due to adsorption. After three days, the removal efficiency of mixed filter decreased, which could have been caused by the exhaustion of the vacant sites for adsorption. The removal efficiency of COD in quarry dust filter increased up to 8 day but from then onwards it decreased. Hence, adsorption and aerobic digestion could contribute the treatment of organic matter in terms of COD in landfill leachate. According to test results, it was found that quarry dust and mixed filters can be used to treat COD in landfill leachate. According to Bagchi (2004), the surfaces of organic matter provide some adsorption sites, in addition they may serve as energy source for microorganisms. Hence, the adsorption could contribute the treatment of organic matter in terms of COD in landfill leachate.

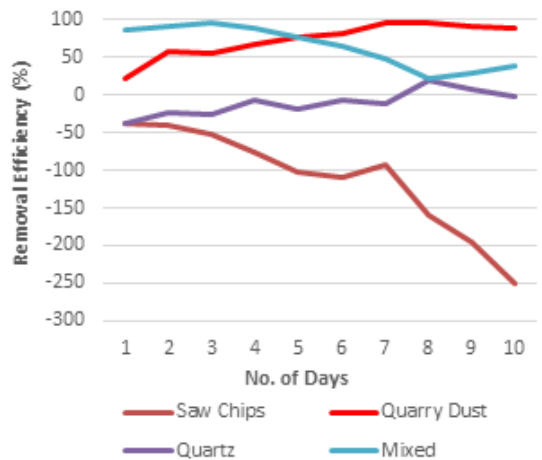


Figure 3. Variation of COD removal efficiency

#### C. Removal Efficiency of Turbidity

Figure 4 shows the variation of Turbidity removal efficiency in four different filter media. The average maximum removal efficiency (95.12%) showed in quarry dust filter column. Mixed and saw chips filters showed an average removal efficiency around 60%. Both mixed and saw chips filters showed a reduction after 11 days and 6 days respectively. The removal efficiency of Turbidity in quartz filter was not satisfied. From the experimental results, it was determined that all filters except quartz filter can be used to treat turbidity in landfill leachate.

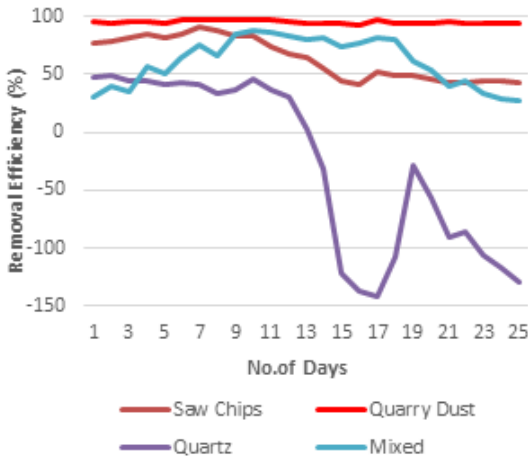


Figure 4. Variation of Turbidity removal efficiency

D. pH values

General pH range of surface water is 6.5 to 8.5. All effluent water samples were within the range of 6.5 to 8.5 for quarry dust, quartz and mixed filters. Average pH values of quarry dust, quartz and mixed filters are 7.35, 7.31 and 7.14 respectively. Few effluent water samples in the saw chips filter were out of range. But the average pH value was inside the range. The average pH value for saw chips filter was found as 6.73.

IV. CONCLUSION

From the analysis of test results, it was found that both quarry dust and mixed filter can be used to treat BOD and COD in landfill leachate. Out of that quarry dust is the most suitable packing media to treat landfill leachate. All the filters except quartz filter can be used to treat turbidity in landfill leachate. All four filter media can be used to treat pH values in landfill leachate. For biodegradable organic materials, the principal treatment mechanisms could be adsorption and anaerobic decomposition.

The study shows the necessity of carrying out these experiments for longer durations to achieve better results

because it would provide sufficient time and optimum requirements for anaerobic microorganisms to reproduce and grow. Table 2 shows effluent characteristics for all four filter media types. According to results, it was found that both quarry dust and mixed filters are suitable to treat landfill leachate.

Table 2. Effluent Characteristics

Packing Media	Average efficiency/ value of the Effluent			
	BOD (%)	COD (%)	Turbidity (%)	pH
Quarry Dust	68.37	72.9	95.12	7.35
Quartz	0	0	0	7.31
Saw Chips	0	0	63.75	6.73
Mixture	52.38	63.7	61.13	7.14

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# SEA LEVEL VARIABILITY IN THE WEST COAST OF SRI LANKA

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**Abstract** - Sea level variability in west coast of Sri Lankan waters was investigated by means of in-situ (Tide gauge) and satellite altimetry data over a period spanning two decades from 1993 to 2014. This paper describes the sea level variations during the mentioned time period retrieved from the two data sets. The gauge data were used from the global network of Inter-Governmental Oceanographic Commission (IOC) and Archiving, Validation and Interpretation of Satellite Oceanographic (AVISO) satellite data.

Mean sea level (MSL) estimates obtained from tide gauge data showed root mean square differences (RMSDs) were approximately 80% of the variance of the MSL signal estimated from satellite altimetry data. Considering the individual time series, the results showed that coastal tide gauge and satellite sea level signals are comparable, with RMSDs less than 4cm and correlation coefficients up to the order of 0.9. Positive sea level linear trend for the analysis period were estimated for both the mean sea level and the coastal stations.

From 1993 to 2014, the mean sea-level trend (1.9824 mm/year) was found to be affected by the positive anomalies of 2008 and 2014, which were observed in all the cases analysed and were mainly distributed in coast of the western and southern Sri Lanka. Analysis of climatology salinity and temperature field and model outputs, it was evident that change in steric sea level (or dynamic height) is the main factor leading to seasonal MSL change and

trend. Ensemble empirical mode decomposition showed that inter-annual variability was related to the processes that have dominant periodicities of 4-6 years related to El Nino Southern Oscillation (ENSO) events. In terms of mean sea level trends, a significant positive sea level trend (>>95%) was found on the basis of at least 10 years of data.

**Keywords** - Steric Height, Sea Level Changes, Sri Lanka

## I. INTRODUCTION

This paper discusses the variation of sea level with the different time intervals in the west coast of Sri Lanka. Sea level is the mean water level, at which the oceans exist when averaged between high and low tides which associated with many kinds of forcing agents in the sea caused by astronomical and hydrological forces. Estimated average annual global mean sea level rise was 2.8 to 3.6 mm yr<sup>-1</sup>. Volume of ocean was increased causing warming the ocean, loss of glaciers and ice sheets, and reduction of liquid water storage on land (Intergovernmental Panel on Climate Change (IPCC) 5th Assessment report 2013).

Sea level variation can be classified according to the time scale which that variability occurs from hours to hundreds of years such as seiches, tsunamis, tides, storm surges, and sea level rise. Such variations under temporal consisted as hours, days, weeks, months, seasonal, annual and inter-annual while spatially can be classified as meso-scale, synoptic, global scale followed by local, regional

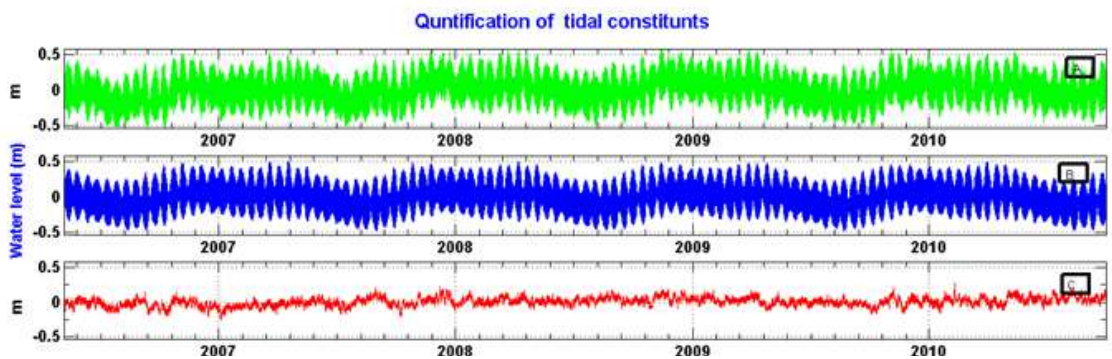
and global scale respectively. The trend of mean sea level variation inferred from altimetry in Northern Indian Ocean (NIO) is  $5 \pm 0.4 \text{ mm/year}$  from the period of 1993-2012 (Indika, 2016). Sea level changes related to density change of specific volume due to change of temperature and salinity is caused by seasonal changes in precipitation, evaporation and heat fluxes which referred to steric height variability (Tomczak and Godfrey, 1994).

The seasonal sea level range around Sri Lankan waters is about 0.2-0.3 m responding to the fresh water inflow, heat flux and other factors that are linked to climate change processes (Wijeratne, 2016). Meanwhile some of extreme variations are governed by sudden changes of atmospheric conditions in disturbed weather system such as Meteotsunami.

This study focused on the study of sea level variations deviate with different time scales using tide gauge and satellite data in the west coast of Sri Lanka.

monitoring station at the fisheries harbour, 'Muttual', Colombo Sri Lanka by the National Aquatics Recourses Research and Development Agency (NARA) were used where achieving, validation and interpretation of satellite oceanographic (AVISO) data were done. The Quantified main tidal component was used for the calculation to obtain spring tidal range and neap tidal range separately according to the methodology of Hicks (2006). The tide pattern was analysed quantitatively using the ratio of  $(K1+O1)$  to  $(M2+S2)$ , the Luni-solar Declinational diurnal constituent (K1), and the Principal Lunar Declinational diurnal constituent (O1). The astronomical effects produced by the moon and the Sun [semidiurnal lunar (M2) and the semidiurnal solar (S2) respectively] were calculated separately where the spring and neap tide variation in the western coast of Sri Lanka was determined. The seasonal and long term

variations were analysed by obtaining monthly mean values taken by high frequency gauge data and satellite



(a). The green line shows the actual tide gauge one minute frequency reading  
 (b). Blue line shows the predicted tidal variation  
 (c). red line shows residual sea level variation

Figure 1: Obtaining of residual sea level variation by separating tidal component.

## II. METHODOLOGY

Global Sea Level Observing System (GLOSS) is an international programme conducted under the auspices of the Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM) of the World Meteorological Organisation (WMO) and the Intergovernmental Oceanographic Commission (IOC). This network consisted of 846 automated sea level monitoring stations where the data are transmitted via satellite communication systems across the world. For this study the gauge data collected from the sea level

separately. The final results of both gauge and satellite were super positioned each for the higher accuracy.

## III. RESULTS AND DISCUSSION

The residual sea level variation was obtained by tidal constituents removed residual tidal variation. The predicted tidal variation was subtracted from actual tide gauge reading obtained from permanent sea level recording stations established in the west coast of Sri Lanka. The calculations were done using tide gauge data

(frequency = one minute) obtained during five years from 2006 to 2011. The quantified tidal constituents assessed separately using 'MATLAB' computer algebra system via the function of T\_TIDE Harmonic analysis of the time series.

The results reveal that M2 is the main tidal constituent in Sri Lanka waters with amplitude of 0.1781 at the phase of 243.3690 (Table1). These figures are in line with the findings of Wijerathne (2006) which stated that the value of M2 super positioned in between 0.10 – 0.18 m depending on the site. The second largest contributor for the tidal effect was S2 where the amplitude and the phase were 0.1233 and 285.9323 respectively. Furthermore, minute effects compared to M2 and S2 were made by K1 and O1.

**Table 1: The resulted tidal constituents obtained quantitatively by harmonic analysis**

Station	ID-33	Amplitude	Phase	
Colombo	M2	0.178	243.36	
		A (m)	g <sup>o</sup>	
	S2	0.123	285.93	
		A (m)	g <sup>o</sup>	
	K1	0.070	307.55	
		A (m)	g <sup>o</sup>	
	O1	0.029	340.1	
		A (m)	g <sup>o</sup>	
	SA	0.08	25.28	
		A (m)	g <sup>o</sup>	
	Spring Tide	2(m2+S2)	0.650	
	Neap Tide	2(m2-S2)	0.1102	

The sea level change within synodic month, it was referenced to the sun (or phase of moon) and is 29.530588 days in length period. It was showed the pattern and the range of tide in the West coast in Sri Lanka. The pattern of tide was mixed semi diurnal with two high tide and two low tides per day with different strength. The variation shows within about 6 hours of time period in two cycles for a day (Hicks, 2006). The spring tidal range and neap tidal range were recorded as about 0.65m and 0.1102 m respectively with regard to the statistical quantification of Hucks (2006). However, according to the gauge reading analysis, these values were observed as about 0.70 m and 0.10 m respectively. Further in line with the findings of Wijerathne (2006), the tide around Sri Lanka was mixed semidiurnal with a spring tidal range of between 0.40 and 0.60 m.

The mean annual sea level variation was obtained by using monthly average sea level values separately. The value was computed as between 20 – 25 cm from both satellite (A) and gauge data (B). The maximum annual sea level variation occurred during December to January while the minimum variation occurred during July to August (Figure 04). Furthermore, the seasonal and long term sea level changed by the effect of steric which the change of temperature and salinity. Moreover, as Wijeratne (2016) explained, the seasonal variation may include some effect from large amount of fresh water discharge to the ocean from main rivers. Accordingly, one of the main influences would be made by fresh water discharges from Kelani River.

Long term sea level variation was analysed using (1) satellite data for a period of 20 years and 10 months, from January 1993 to December 2012 and (2) almost seven years of tide gauge data obtained from May 2006 to March 2012. The mean value of both satellite and gauge data gathered considered period using the linear fitting curve of sea level changed. It shows positive sea level trend in 0.0413 m approximately two decade of time with 1.99 mm annual sea level trend. As explained by Tomczak and Godfrey, 1994, an analysis of climatologically salinity and temperature field and model outputs revealed that change in steric sea level (or dynamic height) is the main factor leading to seasonal mean sea level MSL change and trend.

- (A) Long term variation plotted using satellite data in the West Coast of Sri Lanka.
- (B) Long term variation using tide gauge data in the West Coast of Sri Lanka.
- (C) The trend of the sea level variation during considered period.

## IV. CONCLUSIONS

According to tide classification of Hicks (2006), the underlying form factor was 0.3317, and the tide in the west coast fits the category of 'Mixed Semidiurnal' with two highs tides and two lows tides per day with different strengths. The spring tidal range and the neap tidal range were 0.60 - 0.65 m and 0.5 - 0.15 m respectively under the category of 'Micro tide'. In line with the finding of Wejerathne (2006), the monthly mean sea level ranged among 20-30 cm. The maximum mean sea level change was recorded between December and January while

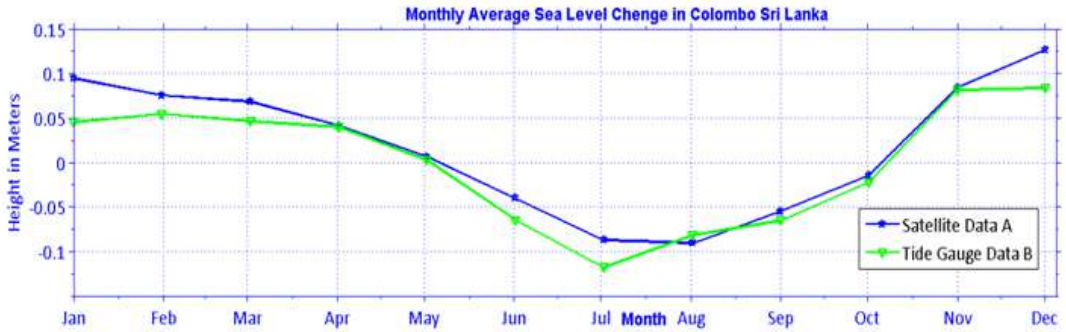


Figure 2. Tide variation within a month period in the west coast.

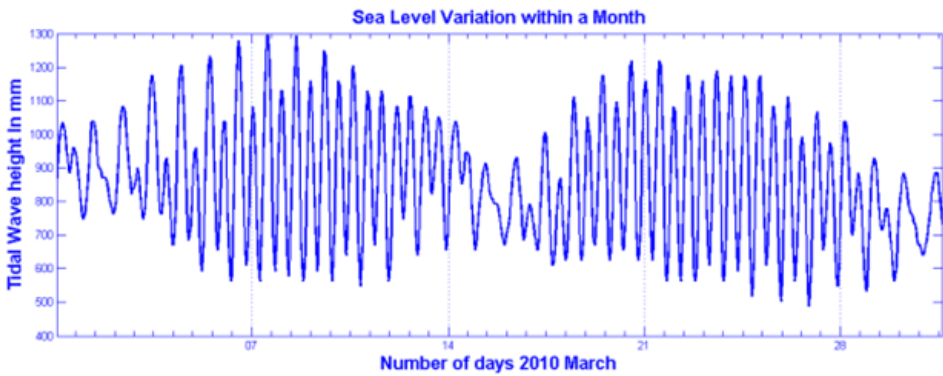


Figure 3. Monthly mean sea level variation in the west coast of Sri Lanka

the minimum level was recorded during July and August where those changes were significantly caused by the 'steric effect'. Long term sea level variation

signifies a positive trend of about 1.9824 mm per annum which is influenced by the effects of global climate change. Inter-annual variability was related

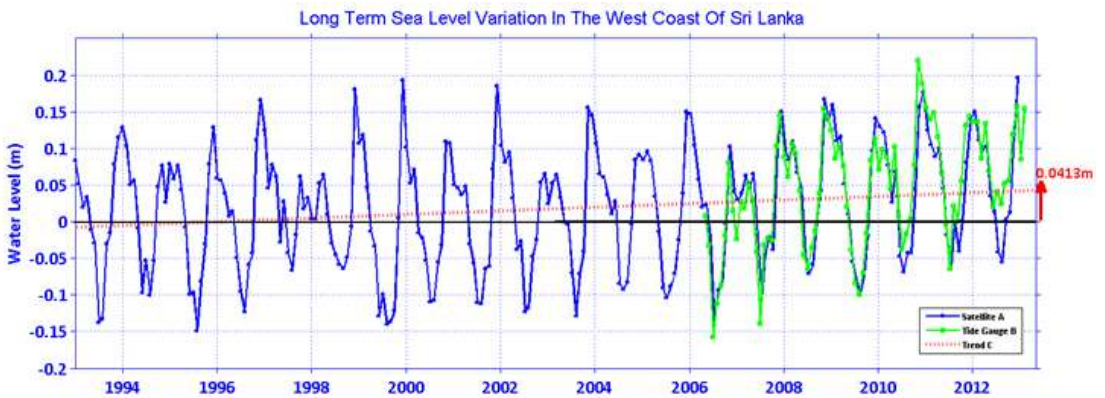


Figure 4: Long term Sea level changes in west coast of Sri Lanka. Blue line shows satellites data for 1993 - 2013 and Green line shows tide gauge record for 2006 - 2013.



to the processes that have dominant periodicities of 4-6 years related to El Nino Southern Oscillation (ENSO) events.

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# DESIGNING A REMOTE MONITORING SYSTEM FOR IMPROVING THE RELIABILITY OF DISTRIBUTION FEEDERS IN SRI LANKA

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**Abstract** - In urban areas feeder pillars are used to sub distribute Low Voltage (LV) underground distribution feeders emerging from distribution transformers or ring main units.

Each feeder pillar consists of several three phase sub feeders and each phase is protected by a fuse. Currently, there is no proper mechanism to monitor the LV distribution network and usage of an industrial monitoring solution would be costly. Therefore, it is problematic for the utility to be aware of a localized power failure or any other undesirable condition in the LV network unless a consumer complains. This reduces the reliability performance of the utility due to increased amount of downtime.

A low cost monitoring unit has been proposed in this research which has the capability of monitoring electrical power related parameters such as voltage, current, active power, power factor and the condition of the fuses of a feeder pillar in order to make the utility be aware of the present situation of the LV distribution network.

The monitoring unit mainly comprises of ADE7758 three-phase energy metering IC, Arduino Mega, fuse condition detection circuits, and a GPRS gateway to transmit measured parameter values periodically to a central server using TCP.

A TCP server was developed to collect data asynchronously from multiple monitoring devices, validate received data and store in a database. To view the data graphically, a HTTP server was developed to display collected feeder

pillar data, estimate transformer loads on the Medium Voltage (MV) side, indicate faults in feeder pillars and transformers and to calculate standard reliability parameters.

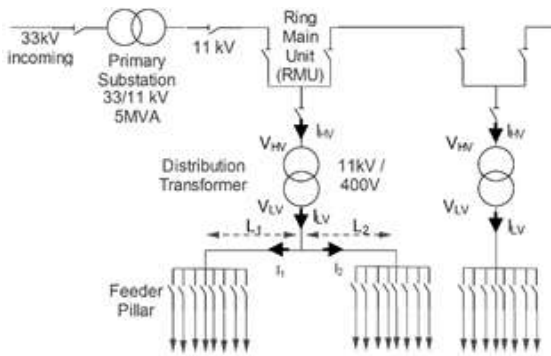
Any faults identified can then be attended to immediately to improve the reliability metrics of urban distribution systems in Sri Lanka.

**Keywords** - Reliability parameters, Remote Monitoring, GPRS, TCP server

## I. INTRODUCTION

In Sri Lanka, electrical power generated from power plants is transmitted through the national grid which consists of two operating voltages: 220 kV and 132 kV. Then, power is distributed among the consumers through the widespread Medium Voltage (MV) and Low Voltage (LV) distribution network.

The 220 kV network carries power from hydro power stations to main load centres while the 132 kV network interconnects the Grid substations (GSS) around the country, which steps down 132 kV to 33 kV feeders. In urban areas, Primary substations (PSS) step down 33 kV to 11 kV feeders which are distributed either as overhead lines or underground cables. In urban areas, such as Colombo, 11 kV feeders are arranged in a ring architecture unlike in suburbs or rural areas where feeders are radially distributed.



**Figure 1. MV and LV distribution Architecture**

In an underground distribution system, Ring Main Units (RMU) are placed along MV feeders to isolate the ring and as well as to distribute power to LV side. A RMU has 2 circuit breakers on either side and a transformer that steps down 11 kV to 400 V. These 400 V lines are then sent to feeder pillars which further distribute power using underground cables to the end consumer. Each LV feeder could serve several domestic consumers depending on their level of requirement.

A typical feeder pillar contains at most, seven outgoing three phase feeder lines. Each phase of feeder pillar is protected by a 160 A ceramic fuse. Currently, the distribution system of Sri Lanka has several problems related to the maintenance and meeting reliability standards.

One such problem is not being able to identify faults such as a fuse being blown out in a transformer or a feeder pillar, immediately unless a consumer complains. Even if the customer complains, utility cannot exactly determine whether the problem is with the fuse or a problem in the consumer installation without a site visit. Therefore, this increases downtime unnecessarily. Moreover, there are other power quality related issues such as over voltages, under voltages, voltage and current imbalances that are not monitored unless it is essentially required.

Another such issue is finding the MV loads for the usage calculation, but measuring MV loads directly is not economically feasible, as it requires costly current transformers.

Utilities constantly monitor certain reliability parameters in order to preserve the standard of the distribution system. Certain standard reliability metrics as given in

IEEE distribution reliability standards are calculated periodically by utilities (IEEE Power and Energy Society, 2012).

These parameters are used as the baseline for determining reliability of service provided to the consumer and currently these are calculated periodically and manually by obtaining past data from either a PSS or a GSS. This approach is time consuming and the level to which the reliability can be calculated is limited up to the level of PSS. Moreover, due to the massive amount of data that needs to be browsed through, this calculation becomes complex and requires special software.

This research aims at developing a cost-effective monitoring system for an upcoming underground LV feeder system in Sri Lanka to address the above-mentioned issues on MV and as well as LV side.

The proposed solution consists of developing two components: An electronic remote monitoring device that can be installed on feeder pillars to monitor LV power parameters and transmit that data to a remote server through GPRS (General Packet Radio Service) and an open source server and database solution for collection, storing and processing data obtained from feeder pillars periodically. The objective of this solution is to improve the reliability through periodic remote monitoring which could be customized according to the needs of Sri Lankan utilities.

## II. METHODOLOGY

Development process of the project initiated with the development of the monitoring unit. Once the initial circuits and Printed Circuit Boards (PCB) were tested, communication and server environments were developed.

### A. Monitoring Unit

ADE7758 poly phase energy metering Integrated Circuit (IC) was used for the measurement of voltage, current and active power of the feeder pillar since it is a widely used IC for smart metering (Weranga, et al., 2014). This IC can be connected to a Microcontroller Unit (MCU) through a Serial Peripheral Interface (SPI) bus for the calculation of real world voltage, current and active power parameters. MCU used for the developed prototype was Arduino Mega 2560, which based on an ATmega 2560 microcontroller. Figure 2 shows a block diagram of the monitoring unit used.

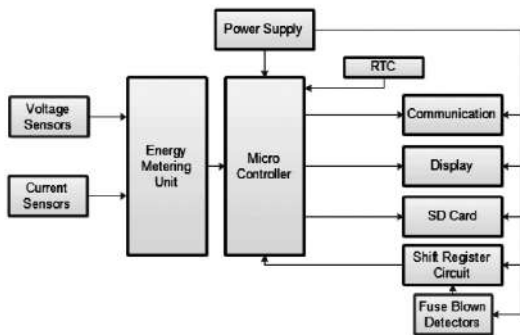


Figure 2. Block Diagram of the monitoring Unit

ADE7758 has the capability to measure the phase voltage 230 V AC that is connected to the IC via a voltage divider circuit, which limits the supply voltage to ±500 mV. It is also able to measure current by converting the current signal too to a voltage signal of ±500 mV through a burden resistor. To measure current, SCT 019 current sensor was used, which gives an output of 0-33 mA for a current of 0–200 A.

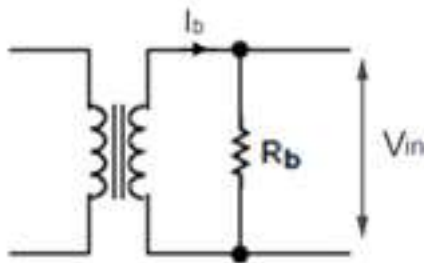


Figure 3. Equivalent circuit for current measurement

$$R_b = \frac{V_{in}}{I_b}$$

By performing the calculations using the equivalent circuit, a burden of 10.7 Ω was selected.

ADE 7758 IC provides its accuracy only for a selected range. For current measurement, IC gave an accuracy level of 0.5% (Guimaraes, et al., 2015). However, for voltage measured from the voltage divider circuit, the IC gave a tolerance of a 2%. Therefore, a Kalman filter was used to get an estimated reading when measuring voltages using the present reading and the previously estimated value.

A circuit was designed to determine the fuse conditions of feeders in the feeder pillar, which outputs 5 V if 230 V AC is detected after the fuse location and outputs 0 V if no

voltage is detected. Since each feeder pillar consists of 21 such fuses, 21 detection circuits were required. Moreover, since it would render the PCB on which the MCU is mounted much larger in area and complex to connect 21 inputs, it was decided to use 3 daisy chained 8-bit shift register circuits. Three 74HC165N 8-bit parallel-to-serial shift registers were used to reduce the 21 inputs to just 4 inputs. A standard GPRS gateway used by Sri Lankan utilities: TMS T50 which has a RS232 serial data input was used for developing the prototype.

MCU was connected to the GPRS gateway using a TTL (Transistor Transistor Logic) to RS232 converter designed using MAX3232 level conversion IC because, the Arduino serial supports only TTL (0 V to +5 V), while the GPRS modem supports RS232 (-13 V to +13 V) voltage levels.

DS1307 Real Time Clock (RTC) was used to synchronize the MCU to the real-world time. The RTC provides the second during which the MCU needs to transmit data to the server. A Thin Film Transistor (TFT) display is placed in the monitoring unit to display the parameters in the feeder pillar such as voltage, current, power factor, active power and fuse status. A SD card module is connected with the MCU to permanently store the parameters measured by the metering IC within the monitoring unit itself as a backup.

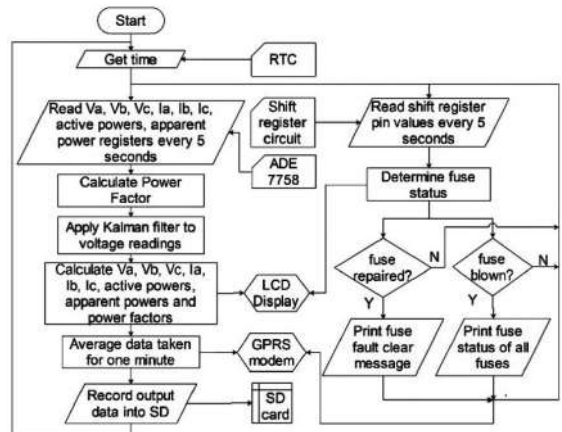
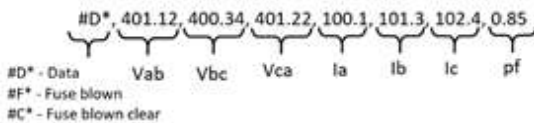


Figure 4. Algorithm developed for the parameter monitoring device

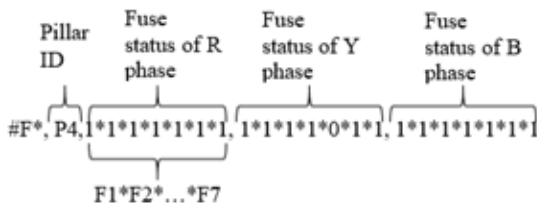
Every 5 seconds, parameters are measured from the ADE7758 IC and is averaged over a minute. Parameters measured are: three phase voltages ( $V_a, V_b, V_c$ ), three line

currents (Ia, Ib, Ic ) and active power. Using these three parameters, line voltages (Vab, Vbc, Vca) and the average power factor (pf) is calculated. This process is illustrated in Figure 4. Every minute, the averaged parameters are transmitted as a single text string to the server using the GPRS gateway as shown in Figure 5.



**Figure 5. Structure of the text string generated every minute which is transmitted from the monitoring unit**

Meanwhile, the monitoring unit is able to monitor the condition of each and every fuse by checking the bit pattern output of shift register circuit every 5 seconds. Fuse status is output as a “1” or “0”, where “1” indicates fuse is operational and “0” indicates fuse is blown.



**Figure 6. Message Format for a fuse blown indication**

When a fuse is blown, the fuse detection circuit detects this due to absence of voltage and outputs a “0”, which is detected by the MCU and at the moment of detection, it sends a message as shown in Figure 6 to the TCP server.

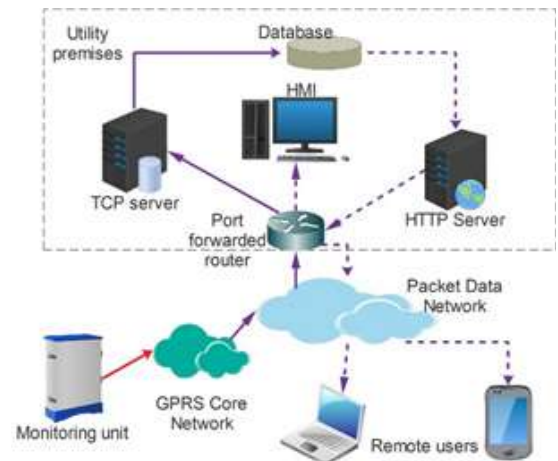
Main power requirements for the monitoring unit was a 12 V and a 5 V power supply. A power supply was designed to fulfil these requirements which would draw power from one of the incoming 230 V lines and a 7 Ah 12 V battery was used as a backup. 5V supply was necessary for the operation of ADE 7758, shift register IC where 12V supply was needed in MCU, GPRS and in making a reference voltage for the fuse blown circuits.

**B. Communication and Server**

Processed data from the monitoring unit is then transmitted to a server in a remote location using GPRS through TCP (Transmission Control Protocol) which

ensures data packet delivery. Even though the standard monitoring period for smart metering and bulk metering is 15 minutes in Sri Lanka, since it is required to monitor sudden changes and indicate faults quickly, the monitoring time period was selected as 1 minute. A time period less than that was not required, since instantaneous changes in the distribution system is generally ignored and knowing any within a minute of occurrence is more realistic. Data is transmitted by the GPRS gateway as one data string per minute and the timing for this process is determined by reading time from RTC.

Two servers were developed for this system: TCP and HTTP (Hyper Text Transfer Protocol) server. TCP server is used to listen to all the communications from each and every monitoring unit connected to a feeder pillar and store data in a database once a data transmission is received. HTTP server is used to serve the stored data in a HTML based format to the user.



**Figure 7. Architecture of the server and communication mechanisms**

1) TCP Server: TCP server was programmed using Node.js due to reduced complexity of programming the server and its ability to asynchronously communicate with many clients at the same time. For the prototype system testing, the TCP server was hosted in a computer connected to a router, which had a static IP address. The server programme was programmed to listen on a specific port, which is not a commonly used port, by other programmes. In the router, port forwarding settings were set to direct all TCP traffic to the local IP address of the computer hosting the TCP server.

The database used for this system was MongoDB, to which, Node.js has native support. MongoDB is a document-oriented database and for each monitoring device, a document is created each hour and the TCP server stores data relevant to each device in the relevant document in the relevant minute (Ramesh D, 2016).

2) HTTP Server: The HTTP server was developed to represent and view the stored data in HTML format. This too was programmed using Node.js, AngularJS and Express.js which too are open source web technologies. The HTTP server was hosted on a different computer, which too was in the same network as the TCP server. The HTTP server serves several web pages to the users who are able to access the system using any device that has internet capabilities provided the user has necessary authorization. This HTTP server provides a platform independent, device independent and location independent service to the user and requires no further licensing. The whole server software provides several services.

**C. Calculations performed by the server program**

1) Estimation of transformer loads and voltages: Each transformer consists of at least one feeder pillar. Therefore, if the loads, voltages and the distance of the feeder of each of the feeder pillars from the transformer is known it is possible to estimate the load and voltage at the transformer. The TCP server has a separate routine, which checks for the load, voltage of the feeder pillar along with the cable distance and impedance per unit length of the cable, which connects each feeder pillar with the relevant transformer. Then, the routine calculates LV and MV load at each transformer along with the voltages by using the below relationships.

$$V_{TLV} = \frac{\sum_{i=1}^{i=n} V_i + \sqrt{3} L_i * R}{n} \tag{1}$$

Where;

- $V_{TLV}$  : Transformer Low Voltage side line voltage
- $V_i$  : Line voltage at the ith feeder pillar
- $L_i$  : Length of the LV line connecting the transformer and the ith feeder pillar in km
- $R$  : Line impedance of the LV line in  $\Omega$ /km
- $n$  : Number of feeder pillars served by the transformer

The MV side voltage( $V_{THV}$ ) is approximated using the turns ratio of the transformer which is 11 kV / 400 V.

$$V_{THV} = \frac{11000}{400} V_{TLV} \tag{2}$$

Similarly, MV side loads can be approximated by accumulating the LV side current loads.

$$I_{TLV} = I_1 + I_2 + \dots + I_n \tag{3}$$

$$I_{THV} = \frac{400}{11000} I_{TLV} \tag{4}$$

Where;

- $I_{THV}$  : Transformer High Voltage side current
- $I_{TLV}$  : Transformer Low Voltage side current

2) Reliability Analysis of the MV feeders: IEEE distribution reliability standards provide definitions for several reliability analysing metrics and out of those, four major metrics were selected to be analysed by this research. SAIDI (System Average Interruption Duration Index): This is a measure of total duration of interruption for the average customer.

$$SAIDI = \frac{\text{Total consumer interruption durations}}{\text{Total consumers served}} \tag{5}$$

$$SAIDI = \frac{\sum_{i=0}^{i=m} N_i T_i}{\sum_{i=0}^{i=m} N_i}$$

SAIFI (System Average Interruption Frequency Index): This shows how often the average customer experiences a sustained interruption.

$$SAIFI = \frac{\text{Total consumer interruptions}}{\text{Total consumers served}} \tag{6}$$

$$SAIFI = \frac{\sum_{i=0}^{i=m} N_i I_i}{\sum_{i=0}^{i=m} N_i}$$

CAIDI (Customer Average Interruption Duration Index): This indicates the average duration of interruptions per customer that had an interruption

$$CAIDI = \frac{\text{Total consumer interruption durations}}{\text{Total consumer interruptions}} \tag{7}$$

$$CAIDI = \frac{\sum_{i=0}^{i=m} N_i T_i}{\sum_{i=0}^{i=m} N_i I_i} = \frac{SAIDI}{SAIFI}$$

ASAI (Average System Availability Index): This is the percentage of time a customer has received power during the reporting period.

$$ASAI = \frac{\text{Total consumer minutes served}}{\text{Total consumer minutes in demand}}$$

$$ASAI = \frac{(T_D \times \sum_{i=0}^{i=m} N_i) - \sum_{i=0}^{i=m} N_i T_i}{T_D \times \sum_{i=0}^{i=m} N_i} \quad (8)$$

where;

- $N_i$  : Number of consumers served by ith transformer
- $I_i$  : Number of failures sustained on ith transformer during selected time period
- $m$  : Total number of transformers on the selected feeder
- $T_i$  : Time in minutes which the ith transformer lost power during selected time period
- $T_D$  : Total selected time period in minutes

### III. EXPERIMENTAL DESIGN

#### A. Monitoring unit

The proposed monitoring unit was prototyped using the hardware components mentioned and the ADE7758 IC was calibrated to measure voltages up to 240V and currents up to 200 A.



Figure 8. The developed prototype-monitoring unit and the TFT display

#### B. HTTP Server user interfaces

1) Geographical view: This is the main interface, which displays any selected MV feeder along with all the transformers and feeder pillars as markers on Google Maps API. It can be used to view the estimated LV and MV loads on transformers and to view the measured parameters and fuse conditions of each monitored

feeder pillar. This view automatically refreshes its data and updates data on the map itself. Additionally, if the TCP sever detects any fault in a feeder pillar or a transformer, that fault too is immediately indicated on the map while triggering an alarm.

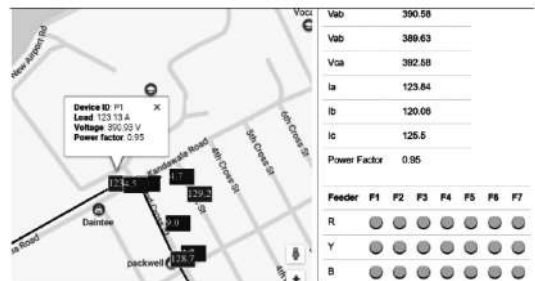


Figure 9. User interface of the main geographical view

2) Reliability parameter calculation: This interface provides the user the ability to calculate reliability parameters such as SAIDI, SAIFI, CAIDI and ASAI for a selected MV feeder. The user has to select a MV feeder, start date and an end date for which the parameters must be calculated. Then, the Node.js server program fetches all the power loss faults associated with each and every transformer that have lasted more than five minutes over the selected period along with the amount of consumers affected and the number of minutes each fault affects a set of consumers. Using these data, the programme calculates all the four reliability parameters using the equations.

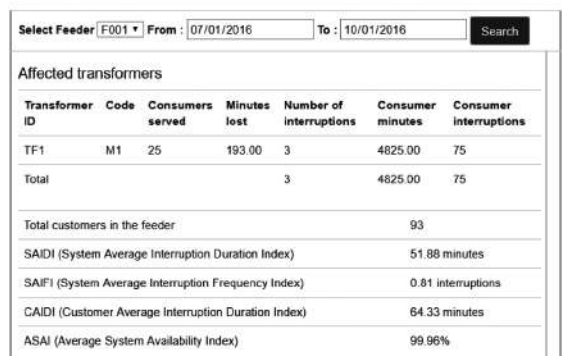


Figure 10. Reliability parameter calculation interface

## IV. DISCUSSION

The monitoring unit was calibrated against a standard panel meter: Siemens PAC 3100, which has an error of 0.01%. The proposed measuring unit was found to provide an error of only 0.5% for voltages greater than 40 V, currents and active powers.

Due to the noise and interference between the components in the support circuit of ADE 7758 IC and due to the voltage divider input the voltage reading was less accurate. Therefore, a Kalman filter was used to make the measured voltage value be closer to the actual value. The Kalman filter predicts the next value of the measurement using the previous predicted value and the measured value (Soliman, et al., 1997).

The monitoring unit and the server system can be even used for an overhead LV distribution system too, if the monitoring device is implemented at the transformer instead of the feeder pillar. Then, it is possible to directly monitor the transformers of the MV feeder and the only change required for the monitoring device is finding a current sensor such as a current transducer which can measure currents of higher magnitudes and some slight changes to the server programme.

This monitoring device is more sensitive for faults that persist more than a minute and an instantaneous fault might not be measured or even if it is measured, as 12 data points are taken within a minute and averaged, the effect of that measurement would be negated by the averaging function.

Any fault that persists more than one minute, would be accurately indicated along with the location and the region which is affected by the fault. Therefore, the fault can be attended to immediately, which would drastically reduce the fault clearing time.

By the time this prototype was developed, underground infrastructure had not been completed and the monitoring unit was not field tested. Therefore, the monitoring unit physical design must be done in order to withstand severe weather conditions and harsh environments.

The TCP server used to collect data and the HTTP server used to view data is web based, which means there is always a higher risk of being subjected to cyber-attacks, for which there should be much stronger threat detection and prevention mechanisms along with proper access control mechanisms.

The risk could be much higher for this type of a system because it uses open source technologies, which everyone has access to learn and use for malicious activities.

The TCP and HTTP server performances need to be tested when handling a large number of monitoring devices and when handling a larger number of viewing devices in order to get a proper understanding of the hardware and software optimizations that need to be done.

## V. CONCLUSION

Through this project we were able to develop a three phase monitoring unit which can measure voltage, current and active power of a LV distribution feeder pillar with an error of 0.5%.

It also can monitor the fuse condition of the feeder pillar indicating if the fuse is blown or not. We were able to develop a server and a database to collect data from monitoring devices and to store in a database.

Unlike a usual SCADA system which requires expensive software and hardware, due to the usage of open source languages, there is no licencing cost for the server system and it provides platform independent performance which means that existing hardware can be used for accessing the system. Moreover, usage of open source software for server and as well as hardware embedded system programming, allows for customization of the system according to the needs of the utility thus enabling pathways for future expansion.

## ACKNOWLEDGEMENT

We wish to convey our gratitude to Dr. Narendra De Silva, Head of Engineering of Lanka Electricity Company Private Limited (LECO) for his valuable advice and guidance for making this research a successful. We also would like to thank Prof. J.R Lucas, Senior Lecturer in KDU for his valuable insights provided. Moreover, our sincere gratitude goes to Eng. Dasun Ranasinghe, who was assisted us in obtaining equipment and information from LECO.

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# SINGLE CARRIER COMMUNICATION SYSTEM ON OPEN SOURCE EMBEDDED PLATFORM

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**Abstract** - Modern open source embedded platforms are very cost effective while providing enormous computing power. Open source embedded platforms with processor clock frequency exceeding 1GHz speed are common and ideal for implementing Digital Communication Transceivers using Software Radio concept. Many of the open source embedded platforms are equipped with an Analog to Digital Converter (ADC) allowing sampling signals exceeding 1MHz rate. This allows implementing Encrypted Digital Data Services using a Software Radio concept.

In this work we have modelled in Matlab Simulink environment, major functions of a Single Carrier Baseband Digital Transceiver, including Pulse Shaping, Carrier Modulation, Timing Recovery, Carrier Recovery, Matched Filtering and Data recovery using, BPSK, QPSK and QAM modulation schemes. The equalization function is not implemented as this is intended for Line of Sight Microwave and Satellite applications where the need for equalization is limited.

The Pulse shaping is performed using Gaussian Pulse Shaping. Timing recovery is carried out using Gardner's Algorithm based technique and Carrier Recovery is implemented using a Costas Loop and its variants implemented in software. A prototypes for BPSK, QPSK and QAM modulation schemes were implemented in MATLAB Simulink environment and BPSK modulation scheme is implemented in an Arduino-Due micro controller using Arduino Development Environment.

The proof of concept in this work shows the potential of software radio in off the shelf embedded hardware.

**Keywords** - BPSK, QPSK, QAM, DSP, Matlab, Simulink, Timing Recovery, Carrier Recovery

## I. INTRODUCTION

Single Carrier Communication has a long history in the Digital Communication Receivers and whether they are inferior to their counterpart Multi Carrier Systems is debatable even today. Using Non-linear frequency domain equalization using widely available FFT hardware allow Single Carrier Communication Systems to have the same implementation advantages of Multi-carrier systems to stay as a competitive candidate. Single carrier systems use a single channel to transmit a broadband signal using data pulses of shorter duration resulting a wideband spectrum susceptible to frequency selective fading. However non-linear equalization allows these channel impairments to be rectified to give performance and simplicity advantage over Multi-Carrier systems.

Therefore in communication applications where direct Line of Sight (LOS) channel is available with insignificant Multi-path interference, single carrier communication is attractive due to its simplicity, spectral efficiency and less memory demanding nature in implementation. Direct Microwave Links and Digital Data modulated streams for satellite communication are potential applications of single carrier systems. Timing synchronisation in single carrier systems are less memory hungry compared to Multi carrier Systems. In OFDM multi carrier system one OFDM symbol worth of data has to be stored internally to perform Cyclic-Prefix correlation to implement timing synchronisation. Even other functions are in the transceiver chain of a single carrier system work sample

by sample basis and therefore less memory demanding. This makes single carrier systems to be attractive for implementing on the embedded hardware as a software radio concept.

## II. METHODOLOGY AND EXPERIMENTAL DESIGN

### A. Transmitter

Transmitter converts binary bit stream into a baseband carrier modulated signal. Carrier modulated broadband signal is then transmitted through wireless channel. In this work, baseband carrier modulated signal is transmitted in a wired medium to avoid radio frequency transmission. The implemented transmitter functions are as follows.

- 1) Bit stream generation: The Transmitter functionality is modelled by generating a continuous pseudo-random unipolar bit stream.
- 2) Unipolar to Bipolar conversion: Created unipolar bit stream then was converted to bipolar bit stream to represent the baseband Binary Phase Shift Keying (BPSK) data.
- 3) Reduction of transmission bandwidth: This bipolar binary data is then converted into a sampled data stream of Gaussian shape pulses to reduce the transmission bandwidth. This was achieved by multiplying the rectangular bit samples by a Gaussian shaped pulse stored in a look-up table. This simpler approach for Pulse Shaping gives a compromise between theoretical rigour of pulse shaping and simplicity in implementation.[1] The sharpened edge of pulses get converted into Gaussian dumbbell shape reducing the required transmission bandwidth while minimizing interference to adjacent channels.

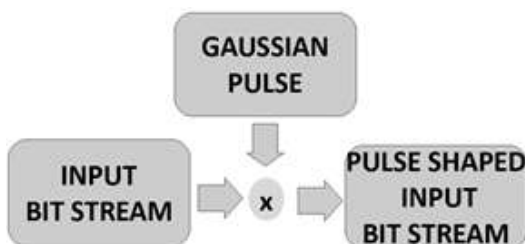


Figure 1. Blocked diagram of pulse shaping using Gaussian pulse

4) Modulation: The Gaussian pulse shaped bit stream are then multiplied by the baseband carrier signal internally generated to be synchronous with the data signal. The carrier frequency is chosen to be ten times the data rate. The modulation scheme and the transmitted symbol determines the starting phase of the carrier. Subsequent up-conversion into an RF carrier (if needed) would increase the carrier frequency as required. QPSK system is modelled by appropriately changing the starting phase of the carrier signal at the start of the data pulse with four possible starting phases separated by 90o in the constellation diagram of input data symbols. In QAM system, both Amplitude and the Phase of the Data signal are varied according to the constellation of the data symbol being transmitted.

The carrier modulated QAM signal is constructed by using Quadrature Carriers modulated with appropriate In-phase and Quadrature data of QAM signal. This prototype implementation does not perform RF carrier modulation. The transmitted signal generated with the Baseband Carrier is used as the receiver input.

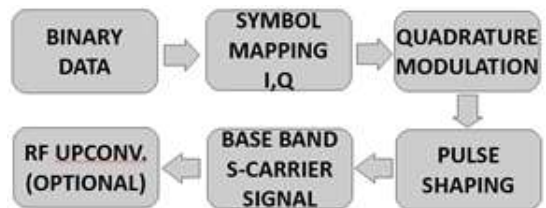


Figure 2. Single Carrier Transmitter Block Diagram

### B. Receiver

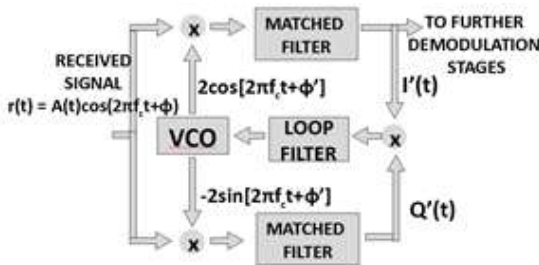
At the receiver the baseband carrier modulated signal is converted to its baseband data signal. The carrier recovery, timing recovery and matched filtering is performed at the receiver for signal synchronization and optimum noise free detection.

- 1) Analog to Digital Conversion: The Receiver samples the baseband carrier modulated signal using the Analog to Digital Converter (ADC) in the embedded platform. The sampling rate set to nominal value of the transmitter sampling rate. The nominal sampling interval is adjusted to be early or late with respect to the regular sampling point by using the timing error generated by the Gardner's algorithm implemented using the baseband data signal recovered later in the receiver chain. [3]

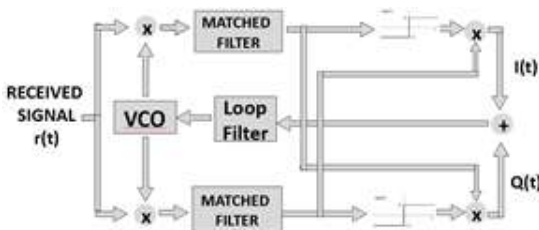
- 2) Timing recovery: The timing error correction compensates for slight frequency mismatch in transmitter and receiver crystal oscillators to stop possible data loss due to accumulated timing error. Timing error corrected signal is then processed for carrier recovery using Costas-Loop, which consists of a Phase Locked Loop that recovers the baseband BPSK data. For QPSK and QAM a slight variation of Costas-Loop is being used. [2] This recovered data down sampled to have two samples per bit to be used in the Gardner's Algorithm for timing recovery at the front-end ADC.
- 3) Carrier recovery and demodulation: The Costas-loop recovers the baseband carrier while giving out the demodulated signal.
- 4) Match filtering: The match-filter is placed within the costas-loop carrier recovery scheme. The matched filter eliminates the out of band noise of the baseband signal. This helps the optimum detection of received signal bits.

**C. Costas Loop**

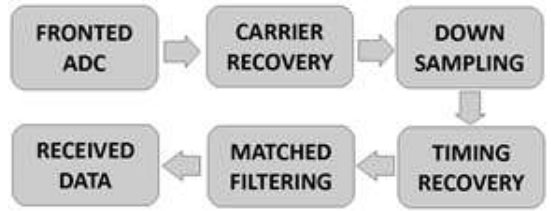
The costas loop performs both phase coherent suppressed carrier reconstruction and synchronous data detection within the loop.



**Figure 3. Block Diagram of the Costas Loop BPSK modulation scheme**



**Figure 4. Block Diagram of the Costas Loop QPSK and QAM modulation scheme**



**Figure 5. Single Carrier Receiver Block Diagram**

Costas loop functionality is based on the orthogonality of  $\sin[\theta(t)]$  and  $\cos[\theta(t)]$  functions.

A signal of the form  $A(t) \cos(2\pi ft + \phi)$  only contains power in the in-phase component. The received signal  $r(t)$  can therefore be described as:

$$r(t) = I(t)\cos(2\pi fct + \phi) + Q(t)\sin(2\pi fct + \phi)$$

Where  $I(t) = 1$  and  $Q(t) = 0$  (BPSK). In practice the VCO is never perfectly synchronized with the carrier therefore both arms of the Costas loop receive some of the signal power as given by the following equation,

$$I'(t) = A(t)\cos(\phi - \phi')$$

$$Q'(t) = A(t)\sin(\phi - \phi')$$

In a Costas loop the input to the loop filter is the product of these two signals.

$$e(t) = A^2(t)\cos(\phi - \phi')\sin(\phi - \phi')$$

$$= 0.5A^2\sin(2(\phi - \phi'))$$

$$e(t) = 0.5A^2(t)\sin(2(\phi - \phi'))$$

Where  $(\phi - \phi')$  is the phase mismatch between the received carrier and local VCO carrier. The loop filter then removes any noise which comes from the term  $A^2(t)$  so that the VCO produces a stable recovered carrier for demodulation.

**D. Timing Recovery**

The receiver never knows the precise bit interval of the pulses as transmitter clock can be slightly offset from the nominal value due to practical reasons. The receiver must know where to take the samples within each symbol interval for the continuous bit stream with no accumulated timing error to eventually slip off bits. Timing recovery consists estimation timing error using Gardner's Algorithm and appropriately offsetting the sampling interval to eliminate the timing error.



Figure 6. Timing recovery Block Diagram

Gardner's Algorithm:

$$\text{Timing Error} = e_n = (Y_n - Y_{n-2})Y_{n-1}$$

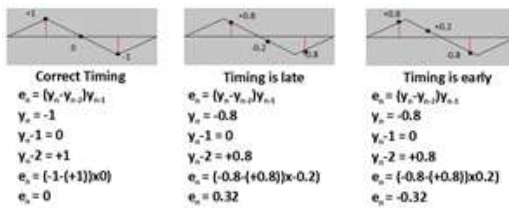


Figure 7. Gardner's algorithm demonstration for correct timing, late timing and early timing

$e_n = 0$ , no timing adjustment is required for the next symbol

$e_n > 0$ , a timing advanced is required for the next symbol

$e_n < 0$ , a timing delay is required for the next symbol

Time spacing between  $Y_n$  and  $Y_{n-2}$  is T seconds.

Time spacing between  $Y_n$  and  $Y_{n-1}$  is T/2 seconds.

### III. RESULTS AND DISCUSSION

MATLAB Simulink models were implemented for BPSK, QPSK and QAM modulation schemes. These models were very useful in implementing the transceiver in real time embedded system. The PID and filter parameters of the system were determined using the Simulink model. The BPSK modulation scheme based transmitter and receiver was implemented on Arduino Due embedded platform that runs on a 80MHz clock. The software model proved that a data signal can be received by eliminating any timing error or carrier error present in the signal before implementation in real embedded hardware. The embedded software was prototyped in Matlab to verify the correctness of the algorithms before implementation. Carrier recovery and Timing recovery were implemented and tested separately and subsequently integrated to make the complete working prototype. The receiver input signal had some noise mixed during the signal transmission through the wired channel. BPSK transceiver implementation was successful in the embedded hardware. QPSK and QAM implementations are more sensitive to recovered

carrier phase and implementation on embedded hardware needs further improvements. The possible effects of slight timing jitter in real-time implementation of a communication system in microcontroller based system compared to dedicated hardware implementation is to be investigated. These aspects will be looked into in the future work.

### IV. CONCLUSION

This project has proved the feasibility of implementation of a single carrier communication system as a software radio concept in embedded hardware. The Gaussian pulse shaping, elimination of Timing error and carrier synchronization error were demonstrated in simulation and real-time hardware. The Gardner's algorithm was used to eliminate the timing error and Costas-loop based carrier recovery method were implemented completely in software. BPSK, QPSK and QAM modulation schemes were implemented in MATLAB Simulink environment and BPSK modulation scheme is implemented in an Arduino-Due micro controller using Arduino Development Environment. Relatively low rate digital transceiver implementation on open source embedded hardware shows potential of low cost solutions in Early warning systems, Internet of Things (IOT) and sensor networks.

### ACKNOWLEDGMENT

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# TIME SERIES MODELLING APPROACH FOR FORECASTING ELECTRICITY DEMAND IN SRI LANKA

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**Abstract** - Both of the electricity production and consumption are playing a significant role in their national economy. To forecast the efficient electricity production and consumption in Sri Lanka, the current study is proposed a systematic and iterative methodology based on the time series modelling approach. Furthermore, the proposed methodology was successfully applied to the data related to the gross electricity generation and total electricity usage in Sri Lanka over the past fifty years from the year 1970 to 2014.

The Box-Jenkins and Autoregressive Integrated Moving Average (ARIMA) based empirical results suggested that ARIMA (3, 1, 1) and ARIMA (1, 1, 1) are suitable and more appropriate for predicting the future demands of electricity in Sri Lanka.

**Keywords** - Box-Jenkins, ARIMA, MAPE, Electricity Production, Electricity Consumption, Forecast, Sri Lanka

## I. INTRODUCTION

Both of the electricity production and consumption are playing a significant role in goods and services. According to the literature, different types of factors are directly affected on the electricity demand of the country. Some of them are; the growing populations, extensive urbanization,

industrialization of economies and increasingly greater use of electrical appliances in daily life have been contributed directly to increase the electricity demands.

Generally, the electricity demand in Sri Lanka is fulfilled based on the three primary sources. They are; thermal power (which includes energy from biomass, coal, and all other fuel-oil sources), hydro-power (including small hydro), and other non-conventional renewable energy sources (solar power and wind power) (CEB Statistics). According to financial reports in 2014, the total electricity generation and total electricity consumption in Sri Lanka is over the 12848.88 GWh (Giga Watts per hour) and 10996.92 GWh respectively, whereas those for the year 1970 is, 785.7 GWh and 619.51 GWh respectively (CEB Statistics, 2014). Furthermore, the statistics suggested that, both of the total electricity generation and total electricity consumption have been increasing rapidly. As a result of these circumstances, forecasting efficient electricity production and consumption in Sri Lanka is playing a significant for their future development.

According to the literature, studies related to the electricity production and consumptions are extremely limited. Furthermore, most of the available studies also have done based on the foreign literature. The study by Amarawickrama and Hunt (Amarawickrama & Hunt, 2007) estimated electricity demand functions for Sri

Lanka using six econometric techniques. By upgrading Amarawickrama & Hunt (2007) methodology, Silva & Samaliarachchi carried out a different study to identify sensitive elements which affect the daily peak demand of Sri Lanka power systems. According to their findings, they developed two forecasting models, based on the multiple linear regression and feed-forward Artificial Neural Network to estimate demands of Sri Lanka from the year 2008 to 2011. The empirical findings with the lowest Mean Absolute Percentage Error (MAPE) concluded that an Artificial Neural Network model is the best fit model for predicting daily peak demand of Sri Lankan power system (Silva & Samaliarachchi, 2013).

In the same period of time, Cooray & Peiris developed a state space based on structural time (SSST) series model to forecast day and night peak values of electricity demand in Sri Lanka for week-days and week-ends (Cooray & Peiris, 2012). In another study, Dissanayake & Perera fitted an Autoregressive Integrated Moving Average (ARIMA) model to forecast for future domestic electricity demand for Sri Lanka by using quarterly data of Electricity demand from 1997 to 2013 (Dissanayake & Perera, 2013).

According to the foreign literatures which are related to electricity demand, production and consumption, Makukule et.al contribution is significant. They have investigated the impact of day of the week, holidays and other seasonal effects on daily electricity demand in South Africa for the period 2001 to 2009 (Makukule, Sigauke, & Lesaoana, 2012). In the same period of time, Yasmeen & Sharif, used ARIMA, SARIMA, and ARCH/GARCH models to evaluate the monthly electricity consumption in Pakistan for the period of January 1990 through December 2011 and concluded that, ARIMA (3,1,2) model is the most appropriate model to forecast electricity consumption in Pakistan (Yasmeen & Sharif, 2014). In 2009, Abosedra et.al (2009) estimated the demand for electricity in Lebanon by employing three modeling techniques namely OLS, ARIMA and exponential smoothing for the time span January 1995 to December 2005. The empirical findings with respect to the lowest RMSE, MSE and MAPE criteria of this study suggested that, the ARIMA (0,1,3) (1,0,0)12 is superior for forecasting under the unstable manner (Abosedra, Dah, & Ghosh, 2009). Kandananond (2011) carried out a same type of study and utilized different forecasting methods such as ARIMA, ANN and multiple linear regressions to formulate prediction models of the electricity demand in Thailand. Based on these error measures they found that, the ANN approach outperformed the ARIMA and MLR

methods (Kandananond, 2011, Seneviratna et.al, 2013). The current study focuses on analyzing and forecasting the efficient electricity production and consumption in Sri Lanka over the past 50 years' worth of data. The rest of the paper is organized as follows: Section II explains about the brief overview of the methodologies. Sections III analyze and compare Sri Lankan electricity consumption results and section IV end up with the conclusion and future work.

## II. MATERIALS AND METHODS

The Demand for electricity exceeds its supply which is called epileptic problem facing by most of the developing countries including Sri Lanka. The average rate of electricity demand for Sri Lanka has gone over 6.7% last three decades. According to the financial reports in 2015, so many modifications have been done in Sri Lankan energy production. Data for this study was extracted from the database of Sri Lanka Sustainable Energy Authority ("Sri Lanka Energy Balance"); especially, Gross Electricity Generation (GWh) and Total Electricity Use in Sri Lanka (GWh) from the year 1970 to 2014 were considered.

### A. Data pre-processing and stationary/non-stationary checking

As an initial step, stationary and non-stationary conditions were measured based on three different unit root statistics, namely, Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and Kwiatkowski – Phillips – Schmidt - Shin (KPSS) test statistics. If series not stationary then regular differencing will be applied.

### B. Time series methods of forecasting

The Autoregressive integrated moving average (ARIMA) models have been successfully applied today in wide areas for predicting future movements of non-stationary data patterns. ARIMA model is a generalization of an Autoregressive moving average model. Basically, it consists three parts (Rathnayaka et.al, 2014, Rathnayaka et.al, 2015, Seneviratna et.al, 2013). They are; the autoregressive parameter (p), the number of differencing passes (d) and moving average parameter (q). The moving average process and the autoregressive process can be written as follows. The autoregressive process of order p is denoted AR (p), and defined by

$$X_t = \sum_{r=1}^p \varphi_r X_{t-r} + \varepsilon_t \quad (1)$$

Where  $\phi_1, \dots, \phi_r$  are fixed constants and  $\{\epsilon_t\}$  is a sequence of independent (or uncorrelated) random variables with mean 0 and variance  $\sigma^2$ . The moving average process of order  $q$  is denoted MA ( $q$ ) and defined by

$$X_t = \sum_{s=0}^q \theta_s \epsilon_{t-s} \quad (2)$$

Where  $\theta_1, \dots, \theta_q$  are fixed constants,  $\theta_0 = 1$ , and  $\{\epsilon_t\}$  is a sequence of independent (or uncorrelated) random variables with mean 0 and variance  $\sigma^2$ . If we combine differencing with auto regression and a moving average model, we obtain a non-seasonal ARIMA model. The full model can be written as

$$X'_t = \sum_{s=0}^q \theta_s \epsilon_{t-s} + \sum_{r=1}^p \phi_r X'_{t-r} + \epsilon_t \quad (3)$$

Where  $X'_t$  is differenced series. The methodology of this study is carried under the three main phases as follows. They are; data analysis, model identification and model validation and forecasting; especially, for, Box Jenkins methodology based ARIMA fitting approach is used. Furthermore, the best model is selected by using Akaike Information Criterion (AIC) value and Schwarz's Bayesian Information Criterion (SBC) value (Rathnayaka et.al, 2016, Rathnayaka et.al, 2014).

**C. Time series methods of forecasting**

As a next step, the diagnostic checks are performed on the residuals to see if they are randomly and normally distributed. Furthermore to check the normality of results, the Jarque-Bera test and Heteroskedasticity ARCH test were used.

If the residuals series of selected model passed diagnostic checking, then the model could be used in predicting future values. The accuracy of forecast error of fitted model is measured by MAPE (mean absolute percentage error). The mean absolute percentage error is given by:

$$MAPE = \frac{1}{n} \sum_{t=1}^n \left| \frac{e_t}{y_t} \right| \times 100 \quad (4)$$

**III. RESULTS AND DISCUSSION**

As an initial step, stationary conditions of both electricity consumption and electricity production were measured using Unit Root test methods named ADF and PP tests

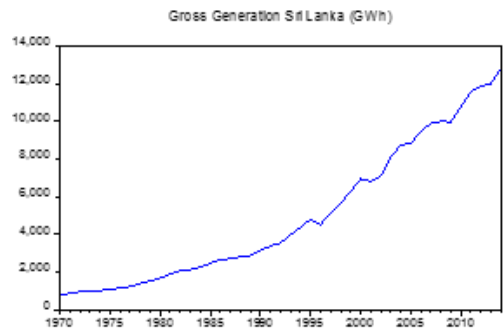
and Schwarz Info Criterion as the selection criteria. The estimated results are presented in Table 1 as follows.

**Table 1: Test results of unit root test**

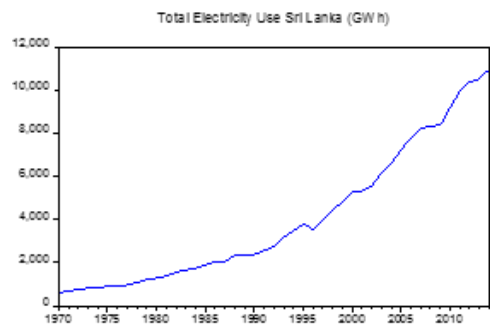
Data Set	Level Data		First Differenced Data	
	ADF Test	PP Test	ADF Test	PP Test
Electricity Production	1.0000	1.0000	0.0002	0.0002
Electricity Consumption	1.0000	1.0000	0.0031	0.0036

As a result of the original data of Electricity Production and Electricity Consumption is not stationary, the first differenced data were considered. According to the Table 1 results, first differenced data of Electricity Production and Electricity Consumption were stationary under the 0.05 level of significance.

As the next step, time series plots of Electricity Consumption and Electricity Production were constructed.



**Figure 1: Electricity Production in Sri Lanaka**



**Figure 2: Electricity Consumption in Sri Lanaka**



Data patterns in Figure 2 illustrate that Electricity Production and Electricity Consumption has quadratic trend during the past 30 years. Furthermore, from year 1970 to 1995, Electricity Production and Consumption in Sri Lanka, shows a smooth quadratic trend, but after year 1995 it has slight fluctuations.

**Table 2: Information criteria for various iterations of ARIMA (p,1,q) for Electricity Production**

ARIMA(p,1,q)		q-(MA)			
		0	1	2	3
p-(AR)	0		14.542	14.559	14.586
			14.623	14.680	14.748
			14.572	14.604	14.646
	1	14.461	14.188	14.230	14.052
		14.542	14.310	14.392	14.255
		14.491	14.233	14.290	14.128
	2	14.493	14.395	14.797	14.097
		14.615	14.395	14.999	14.341
		14.538	14.293	14.871	14.188
	3	14.244	14.036	14.061	14.101
		14.406	14.238	14.305	14.385
		14.304	14.111	14.152	14.206

**Table 3: Information criteria for various iterations of ARIMA (p,1,q) for Electricity Consumption**

ARIMA(p,1,q)		q-(MA)		
		0	1	2
p-(AR)	0		14.053	13.967
			14.134	14.088
			14.083	14.012
	1	13.774	13.593	13.606
		13.855	13.715	13.768
		13.804	13.638	13.666
	2	13.793	13.621	14.266
		13.915	13.783	14.469
		13.838	13.681	14.341

Among the above information criteria, the models with the lowest AIC value were chosen as the most suitable models. The best model chosen for Electricity Production was an ARIMA (3,1,1) model (Table 2) and for Electricity Consumption was an ARIMA (1,1,1) model (Table 3). The coefficients, standard errors and probabilities of parameters of the fitted models were described in Table 4 and Table 5. Since the probability value for each parameter is less than 0.05, we may conclude that the fitted models were consistent with the data for both Electricity Production and Consumption.

**Table 4: Fitted ARIMA model for Electricity Production**

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	0.884880	0.144372	6.129045	0.0000
AR(2)	-0.410534	0.183455	-2.237793	0.0310
AR(3)	0.513916	0.135292	3.798569	0.0005
MA(1)	-0.722975	0.129389	-5.588483	0.0000
SIGMASQ	54654.40	12365.56	4.419890	0.0001

**Table 5: Fitted ARIMA model for Electricity Consumption**

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	0.991153	0.029226	33.91281	0.0000
MA(1)	-0.806450	0.142199	-5.671290	0.0000
SIGMASQ	39217.12	9593.670	4.087812	0.0002

As the next stage of this study, diagnostic checking was carried out for all selected models. Jarque-Bera test was used to check normality and Heteroskedasticity ARCH test was used to check for ARCH effect. The results are shown in Table 6. The Jarque-Bera test results indicated that, the residuals are independently distributed. Furthermore, the Heteroskedasticity ARCH test results indicated that both models have an ARCH effect.

**Table 5: Results of Jaque-Bera test and Heteroskedasticity ARCH test**

Data Set	Jarque-Bera test		Heteroskedasticity ARCH test	
	Test Statistic	p-value	Test Statistic	p-value
Electricity Production	2.0669	0.3557	8.9182	0.0047
Electricity Consumption	1.9008	0.3865	5.9660	0.0190

## IV. CONCLUSION AND RECOMMENDATIONS

In this paper, we developed a systematic and iterative methodology of Box-Jenkins ARIMA forecasting for Electricity Consumption and Electricity Production. After the test of stationary, we conclude that the data is stationary at first difference, E-views software is used for fitting the coefficient of the model, using graphs, statistics, ACFs and PACFs of residuals and after several iterations, the models selected are ARIMA (1,1,1) for Electricity Consumption and ARIMA (3,1,1) for Electricity Production.

The empirical results suggest that ARIMA (1,1,1) model can be used for Electricity Consumption and ARIMA (3,1,1) model can be used for Electricity Production for short term forecasting. In this study we identified that both ARIMA (3,1,1) and ARIMA (1,1,1) models has an ARCH effect, hence it can be improved in the future, by moving to a higher model, such as ARCH model, for both Electricity Production and Consumption.

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# FABRICATION AND EVALUATION OF A SRI LANKAN GRAPHITE BASED RECHARGEABLE BATTERY

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**Abstract** - Renewable sources such as solar, wind and tidal have been recognized as suitable low cost and environmental friendly solutions for energy production. To store their energy to meet the continuous demand of power, energy storage devices are of utmost importance. Batteries and capacitors are the two main storage devices use commonly. At present, there is a huge concern over their safety as well as their price.

This paper reports about fabrication and evaluation of a Zn and graphite based battery that uses a gel polymer electrolyte (GPE) instead of a liquid electrolyte. Graphite was mixed with polyvinylidene fluoride as a binder in the weight ratio 85 % : 15 %. GPE was consisted with polyvinylidene fluoride, ethylene carbonate, propylene carbonate and zinc trifluoromethanesulfonate. Hot pressed method was used to prepare the GPE. Assembling of the battery was done inside an Ar filled glove box. The open circuit potential was found to be about 1.03 V. Cyclic Voltammetry (CV), Galvanostatic Charge Discharge (GCD) and Electrochemical Impedance Spectroscopy (EIS) techniques were used to analyse the performance of batteries.

The capacity values were satisfactory and the capacity fade over continuous cycling was rather low. With the CV test as well as the GCD, it was noted a sudden drop of capacity initially. But, after some cyclings, the rate of reduction has decreased. It may be due to material stabilization, electrolyte - electrode interface formation. No parasitic effects or resistive layer growth was observed in the impedance plot. Further studies are being carried out to improve the performance further.

**Keywords** - Rechargeable batteries, Gel polymer electrolyte, Cyclic Voltammetry.

## I. INTRODUCTION

To meet the future challenge of supplying energy in a reliable way, renewable sources such as solar, wind and tidal have enormous potential [Budischak, et al. (2013)]. But, to maintain a continuous supply, energy storage devices are essential. They are so critical to effectively level the cyclic nature of renewable energy sources. Since time immemorial, batteries and capacitors have been grouped as the two main energy storage devices [Xiong, et al. (2014)]. Even today, they are the key powering enablers in numerous applications ranging from transportation to consumer electronics. Batteries store more energy than capacitors and hence they are being used for instances where high energy is required. Primary batteries can be used only once and secondary or the rechargeable batteries can be charged to use many times. Today, much attention is on rechargeable batteries due to the provision of reuse after recharge. Li, Li ion, nickel metal hydride are some of the rechargeable batteries commonly used in applications [Scrosati, et al. (2010), Lu, et al. (2013)]. Even after several charging cycles, they have to be disposed. Nowadays, there is a great concern with their environmental friendliness specially at the stage of disposal as well as their cost. As such, several strategies have been introduced such as replacing hazardous materials like Li, employing non liquid electrolytes and using low cost materials. In that line, Zn, Mg, Na have been identified as some of the suitable alternatives to use for the anode instead of Li [Sheha, (2013), Weerasinghe, et al. (2016)]. Also, they are proven to be cheaper than many of the anode materials. As far as Sri Lanka is concerned, much attention should be given for the safety issues. Being a small island, the disposal of hazardous materials is a threat for the well-being of not only the humans but also for the flora and fauna. In Sri Lanka, there are a large number of natural resources

and among them, graphite has been identified as a good electrode material for rechargeable batteries. Due to the inherent drawbacks of liquid electrolytes, many research groups have focused their attention on gel polymer electrolytes (GPEs) which are showing liquid like ionic conductivities with quasi solid state properties. They are consisted with a polymer network, salt and solvent/s. Due to their excellent properties, they have been investigated for various applications including batteries, capacitors, solar cells and electrochromic devices [Jayathilake, et al. (2014)]. In this paper it is described about a rechargeable battery fabricated using a GPE, a graphite cathode and a Zn anode. This is a kind of an environmental friendly, low cost battery which may be able to compete with the other rechargeable batteries in the market. Also, this type of a battery configuration has not been studied before as per our literature review. The use of Sri Lankan graphite with a GPE is a novelty in the study. If it is possible to develop the battery to get satisfactory performance, there will be a value addition to a Sri Lankan natural resource in the field of energy.

## II. METHODOLOGY AND EXPERIMENTAL DESIGN

### A. Preparation of the gel polymer electrolyte

Polyvinylidene fluoride (PVdF) (Aldrich, 99%), ethylene carbonate (EC), (Aldrich, 98%), propylene carbonate (PC) (Aldrich, 99%) and zinc trifluoromethane sulfonate ( $Zn(CF_3SO_3)_2$ ) (Aldrich, 99%) were used without further purification. Required amounts were weighed and magnetically stirred for some time. Then, heating was done at 120 °C for 30 minutes. The resulting hot viscous mixture was pressed in between two well cleaned glass plates and on cooling, it was possible to obtain a thin, flexible film.

### B. Preparation of the graphite based electrode

Graphite sample which was received from Bogala Graphite Lanka PLC was used as received. It was mixed with PVdF in the weight ratio 85 % : 15 %. A homogenous slurry was prepared using acetone. It was then deposited on a stainless steel dice.

### C. Fabrication of the battery

A circular shape electrode was cut from Zn received from Aldrich. An electrolyte film of the same shape and area was cut and it was sandwiched in between the Zn electrode

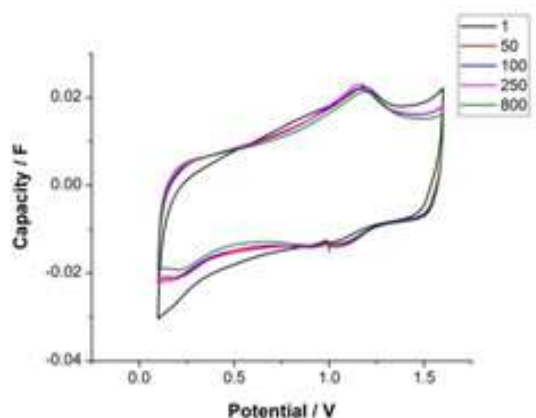
and the graphite electrode. The cell was housed in side a brass sample holder. All the fabrication procedures were carried out in side an Ar filled glove box.

### D. Evaluation of the performance of the battery

Firstly, the open circuit potential was measured. Cyclic Voltammetry test was done using the Zn electrode as the reference and counter electrodes and graphite electrode as the working electrode with a Metrohm 101 potentiostat. The scan rate used was 5 mV/s. Cycling was done in the potential window 0.1 V to 1.6 V for 800 cycles continuously. Continuous galvanostatic charging and discharging of the battery was carried out in the potential range 0.1 V to 1.4 V. The constant current used was  $120 \times 10^{-6}$  A. Measurements were taken for 1500 cycles. Impedance data were collected in the frequency range 400 kHz to 0.01 Hz at the room temperature using a Metrohm 101 Impedance Analyser.

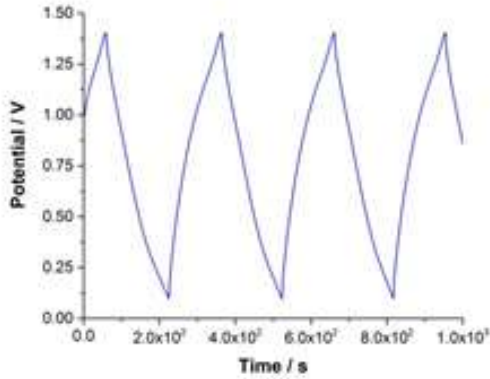
## III. RESULTS

Open circuit potential was 1.03 V. Fig. 1 shows the cyclic voltammograms obtained for the battery at cycles 1, 50, 100, 250 and 800.



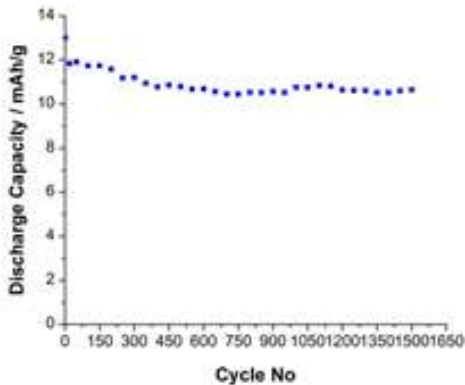
**Figure 1. Cyclic Voltammograms obtained for the battery of the configuration, Zn / PVdF : EC : PC :  $Zn(CF_3SO_3)_2$  / Graphite at different cycles**

Initial charging and discharging cycles obtained for the battery are shown in Fig. 2.



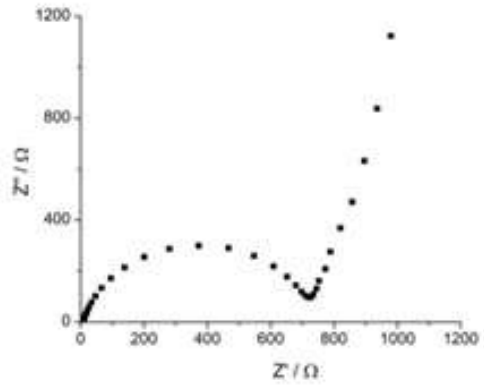
**Figure 2. Initial charge discharge cycles of the battery of the configuration, Zn / PVdF : EC : PC : Zn(CF<sub>3</sub>SO<sub>3</sub>)<sub>2</sub> / Graphite under a constant current of 120 x 10<sup>-6</sup> A**

Fig. 3 shows the variation of discharge capacity with cycle number.



**Figure 3. Discharge capacity variation with the cycle number for the battery of the configuration, Zn / PVdF : EC : PC : Zn(CF<sub>3</sub>SO<sub>3</sub>)<sub>2</sub> / Graphite under a constant current of 120 x 10<sup>-6</sup> A**

Fig. 4 shows the Nyquist plot drawn using the impedance data.



**Figure 4. Nyquist plot for the battery of the configuration, Zn / PVdF : EC : PC : Zn(CF<sub>3</sub>SO<sub>3</sub>)<sub>2</sub> / Graphite obtained at room temperature**

#### IV. DISCUSSION

In cyclic voltammograms, cathodic peak appears at the potential 1.09 V. This is due to the plating of Zn on the cathode [ Kuo, et al. (2002)]. Stripping of Zn can be seen on the reverse scan as the anodic peak at 1.18 V. Anodic and cathodic peaks appear at near equal potentials. This proves the proper functioning of the battery. There are no other visible peaks. This can be used to express that the battery has sufficient electrochemical stability to allow safe operation without undergoing any unwanted reactions. Capacity at 1st cycle was about 27.6 mAh/g where as it was 25.6 mAh/g at 800th cycle. It was noted that after several initial cycles, the capacity has reached a continuous value and the reduction upon continuous cycling is very low. This is a good indication for the absence of any unwanted, parasitic reactions. If such reactions were present, it can expect a considerable reduction of capacity. Also, it is evidenced that battery gains some maturity after several cycles. Due to that, a slight capacity decrease is observed at initial cycles followed by nearly steady capacity with increasing cycle number. At each cycle, the shape of the cyclic voltammogram remains unchanged. This is due to the wide electrochemical stability of the GPE used in fabricating the battery. If it were not stable, sudden current increments may take place disturbing the shape of the cyclic voltammogram.

In Fig. 2, identical charge discharge pattern can be seen at each cycle. This is a good indication to prove the absence of unwanted reaction. Also, it should be highlighted the negligible IR drop at discharge. If it were present, there would be a drastic sudden potential drop at discharge cycles.

The initial discharge capacity was about 13 mAh/g and 11 mAh/g at 1500th cycle. Initially, a sudden drop of discharge capacity can be seen. But, upon continuous cycling, the drop of discharge capacity has reduced. The reduction of capacity may be attributed to material stabilization, electrolyte – electrode interface formation as observed in cyclic voltammograms. [Aliahmad. et al, (2013)]. Also, the potential may drop initially due to polarization build up effect which affects the capacity [Agrawal, et al, 92013)]. From the cyclic voltammograms, the available charge during both charging and discharging processes are calculated as the capacity. But, in galvanostatic charge discharge, only the discharge capacity is calculated. Cyclic Voltammetry results show a capacity value of 27.6 mAh/g for the first cycle. The discharge capacity obtained from galvanostatic charge discharge test for the initial cycle is 13 mAh/g which is nearly the half from the capacity value present with cyclic voltammetry test. This is an indication for the comparability of the two tests.

In general, the high frequency, mid frequency and low frequency regions of a Nyquist plot are attributed to the properties of the bulk electrolyte, charge transfer at the interface and capacitive behavior [Westerhoff. et al, (2016)]. The high and mid frequency regions are governed by the ionic motion in the system [Larfaillou, et al, (2016)]. At high frequency region, a semi circle should appear representing the bulk electrolyte. In this plot, it is absent due to the unavailability of required high frequency. The bulk electrolyte resistance was found from the first intercept on the real axis and was about  $3\Omega$ . The second semicircle was used to calculate the corresponding charge transfer resistance and it was about  $720\Omega$ . The low frequency region is governed by the electrode polarization. The spike at the low frequency region represents a capacitive behavior. It is expected that at low frequency region, charges tend to accumulate on the electrodes. Because of this, a capacitive behavior is present. If the pure capacitive nature was available, the spike is parallel to the imaginary axis. Tilted spike is due to some facts such as uneven surface of electrodes and diffusion controlled behavior. Data clearly confirms the absence of any parasitic effects or any formation of resistive layers.

## V. CONCLUSION

A battery of the configuration Zn/PVdF : EC : PC : Zn(CF<sub>3</sub>SO<sub>3</sub>)<sub>2</sub> / Graphite : PVdF was successfully fabricated. Open circuit potential was 1.03 V. Initially, battery needs to mature by stabilizing the materials and forming good interfacial contacts between the electrolyte and electrodes. Capacity fade over continuous cycling is low. And also, GPE is rather stable with the electrode materials. Results obtained with CV test, continuous charge discharge test as well as with impedance test, prove the absence of parasitic reactions that disrupt the proper performance of the battery. The bulk electrolyte resistance is very low. This is an indication for the high ionic conductivity of the GPE used for the present study. This type of battery can be used for low power requirements with the benefits of the low cost and the safety. Further studies are being progressed to improve the performance.

## ACKNOWLEDGEMENT

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# A NOVEL APPROACH TO IMPLEMENT A CLOSED LOOP CONTROLLED POWER CONVERTER IN THERMAL VACUUM TUBES

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**Abstract** - In electronics, vacuum tube or electron tube is a device that controls electric current between electrodes in an evacuated container. Vacuum tubes mostly rely on thermionic emission of electrons from a hot filament or a cathode heated by the filament. One of the critical issues of these vacuum tubes is, maintaining the powered filament tube for a long time. Filament gradually becomes weak due to irregularities in supply voltage and higher heat generation. Weak filament can be easily identified by observing the reduced output power of the tube. Sudden filament supply failures and irregularities in supply cause the filament to be deteriorated. In this approach, we consider a self-controllable switching power supply which produces a ramp voltage output by varying firing angle of thyristors with respect to time.

To generate the ramp voltage, the power converter is introduced. The ramp voltage is set as the input power supply to the filament. Such power supply helps minimize possibilities to occur sudden and huge current spikes which are capable to harm filament. Proposed power converter consist of a pulse generator to generate PWM pulse, a pulse amplifier to step up the input voltage, an initiator to create basic ramp signal, a synchronizer to match triggering pulses with ac line input, a supervision circuit to detect faults and a communication unit for dealing with plant's main control unit. Here, a controllable AC output is used for the purpose of pulse generation and supervision. Constant negative ramp voltage generated through the initiator circuit is fed to a differential amplifier to obtain an inverted output which is decreasing with time.

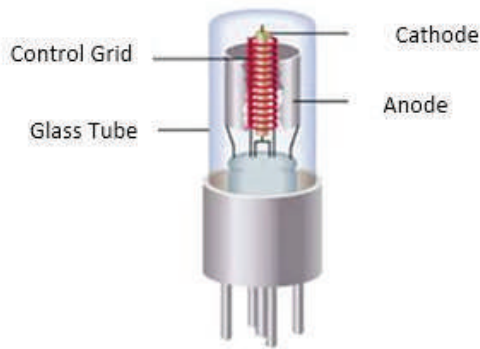
The pulse generator is built with a RC circuit of which charging time is proportional to the output voltage

of the differential amplifier. The RC circuit fires a PNP diode to generate a low voltage basic pulse. It is recognized that the generated pulse is not sufficient enough to fire two back to back thyristors configured in the thyristor bank. A pulse transformer and amplifier circuits are occupied to step up the generated pulses. Finally amplified pulses are fed to a gate of the three terminal thyristors to fire up and obtain the desired output voltage of the converter. This approach makes the filament supply voltage a reliable input regardless of the magnitude or a specific application.

**Keywords** - Power-Converter, Rectifier, Thermal, Thyristor, Vacuum-Tube

## I. INTRODUCTION

Thermal electron vacuum tubes are mainly used in high power radio transmitters, X-ray machines, research laboratories, etc. Most probably those are high expensive devices in many applications such as 250KW short wave radio transmitters. In an electron tube, electric current is controlled between electrodes in an evacuated chamber [2]. Thermionic tube or thermionic valves are commonly recognized as devices which emit thermionic electrons from a hot filament. The simplest vacuum tube, the diode, contains only a heater, a heated electron-emitting cathode (the filament itself acts as the cathode in some diodes), and anode. Current can only flow in one direction through the device between the two electrodes, as electrons emitted by the cathode travel through the tube and are collected by the anode. Adding one or more control grids within the tube allows the current between the cathode and anode to be controlled by the voltage on the grid or grids [4].



**Figure 1. Thermal Electron Vacuum Tube with a Control Grid [4]**

These electron tubes are similar to transistors, but employed in high power applications. Internal electron flow from cathode to anode decides the operation and functions of a cathode tube device. The electron flow is crafted by its filament and the life time of the tube is significantly affected by the quality and properties of the filament. In addition to that supply voltage Filament supplier is one of the most critical functional blocks in entire application.

## II PROPOSED APPROACH

**Figure 2 presents the basic overall picture of the power converter design which include major components,**

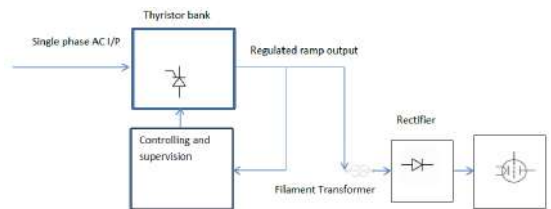
- Pulse generator to generate PWM pulse
- Pulse amplifier to step up the input voltage
- Initiator to create basic ramp signal
- Synchronizer to match triggering pulses with AC line input
- Supervision circuit for fault detecting
- Communication unit for dealing with plant’s main control unit

Primarily, the output of the power converter, i.e. the filament supply voltage should resist load and source fluctuations. Also it must be able to increase gradually in the form of a ramp input.

For the control strategy, the output must always be monitored and, fault detection and indication must also be a part of the system. Further proper safety and

communication mechanism has to be established for the entire plant. Apart from those, the converter output has to be in lined with the following numerical values.

- Output current: 300A (rms),
- Maximum capacity: 3KW,
- Full filament voltage ramp: 10V,
- Confirmation signal is issued to main control system of plant at 5s.



**Figure 2. Overview of the power converter with major components**

## III. FUNCTIONAL DESCRIPTION

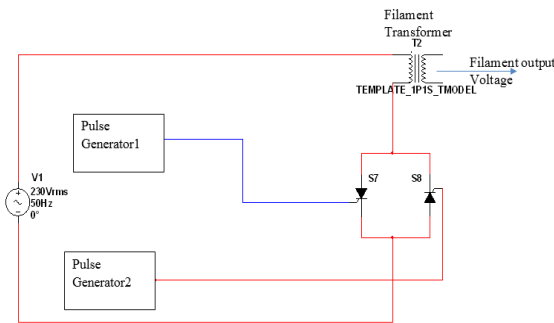
Figure 5 (next page) presents overall block diagram for the Thermal Stabilizer. In the diagram UA is the controllable AC output. UA is fed to T1 and T3 for the purpose of pulse generation and supervision respectively. Output of the T1 is reduced by voltage divider configured through resistors and it is fed to a RMS to DC converter (AD532) which the output is directed to non-inverting input of a differential amplifier. Inverting input of the differential amplifier is set to a constant negative ramp voltage generated through the initiator circuit.

Differential amplifier gives an output which is decreasing with time due to constant negative ramp voltage input. Pulse generator is built with a RC circuit of which charging time is proportional to the output voltage of the differential amplifier.

The RC circuit fires a PNP diode (two pin) to generate a low voltage basic pulse. It is recognized that the generated pulse is not sufficient enough to fire the back to back thyristors configured in the thyristor bank. A pulse transformer and amplifier circuits are occupied to step up the generated pulses.

Finally amplified pulses are fed to a gate of the three terminal thyristors to fire up to obtain the desired output voltage of the converter.

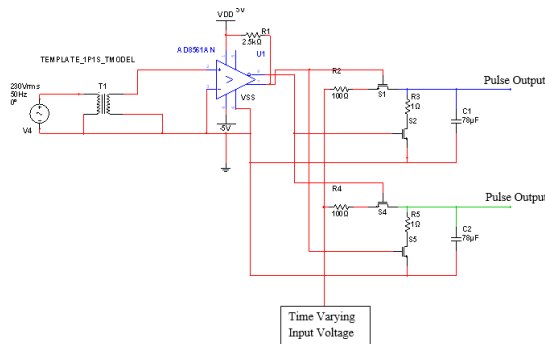
**A. Power System Overview**



**Figure 3. Back to back controllable thyristor rectifier**

Figure 3 is a simple format of the block diagram shown in Figure 5 which presents the overview of the Thyristor Rectifier as a circuit diagram. Voltage drop across or current through the primary of filament transformer is controlled by pulse generators which generate firing pulses for S7 and S8 thyristors. A phase shift of 180° is maintained between two pulse generators to ensure the equal firing of positive and negative cycles to the line supply.

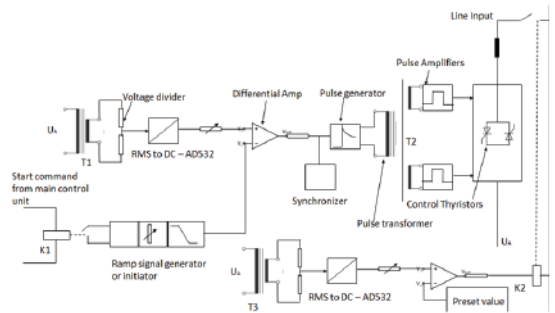
**B. Pulse Generators**



**Figure 4. Pulse generators**

Figure 4 shows the proposed pulse generator circuit. Here, AD8561; a high fast dual output analog comparator is used. Stepped down line voltage from the T1 transformer is compared with zero reference voltage to produce switching pulses for S1, S2, S4 and S5 MOSFET switching transistors. Pin7 and Pin8 of the comparator are set for complementary outputs. Input voltage for Pulse Output1 and Pulse Output2 is common. It is a time

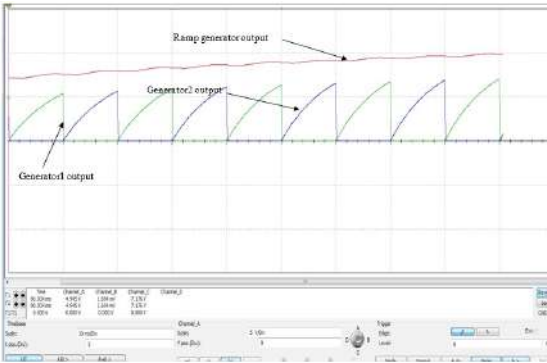
varying supply voltage to ensure the time gap between generated pulses gradually reduces so that firing angle gradually increases with the time being until the stable pre-set value is reached.



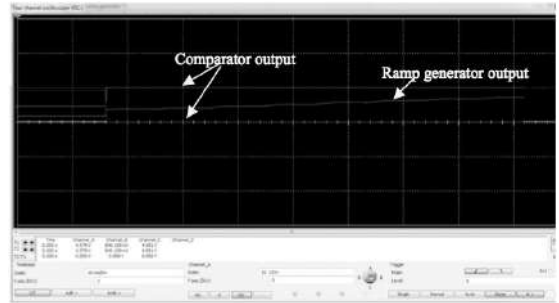
**Figure 5. Complete block diagram of the proposed thermal stabilizer**

**IV RESULTS AND DISCUSSION**

Figure 6 shows the pulse generator and ramp generator output waveforms with respect to circuit diagrams shown in Figure 4 and Figure 8, respectively. In Figure 4, during the positive half cycle, the input voltage is fed to non-inverting input (pin 2) of the comparator. This voltage is compared with zero reference voltage given at the inverting input (pin 3). Consequently, pin7 gives a positive 5V pulse output and at the same time pin8 stands with a 0V output due to the complementary property. Therefore, S1 and S5 attain switched-on state, while S2 and S4 attain switched-off state. When S1 is switched-on, C1 capacitor starts charging. After for a while, C1 will reach triggering voltage of S7 thyristor [Figure 4]. The time duration to reach triggering voltage directly depends on the nature of the time varying input voltage. In another view, during the positive half cycle only S7 thyristor is fired. Concurrently, S5 MOSFET is switched on and pre-charged C2 is discharged instantly due to low resistor value of R5. Same procedure is applied in negative half cycle except status of switching devices.



**Figure 6. Pulse generator output and ramp voltage input**

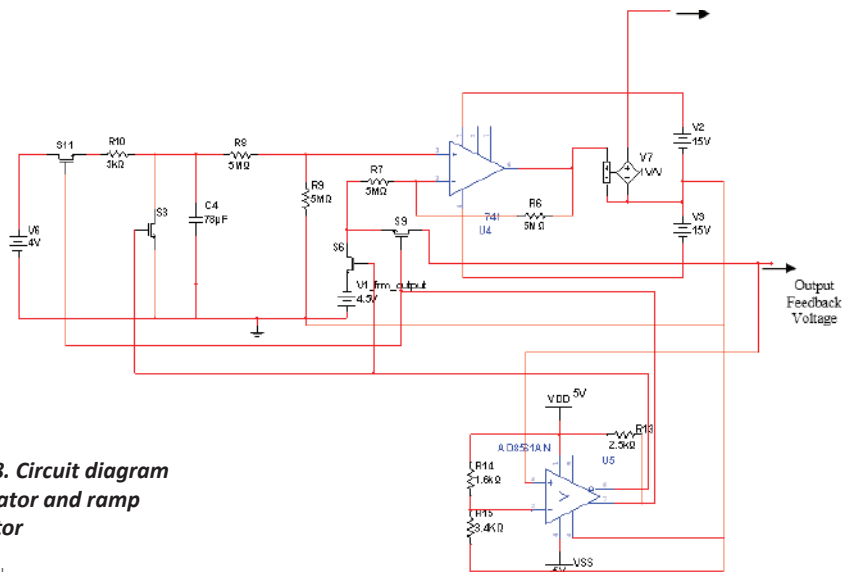


**Figure 7. Output waveforms; ramp and comparato**

Figure 7 illustrates outputs of both initiator and ramp generators presented in the proposed circuit in the Figure 8. At the beginning output voltage is set to zero. Output feedback voltage is compared by AD8561 of which pin2 is set for output feedback voltage. Voltage at pin3 is pre-set to 3.4V in this circuit (According to our application). At the beginning, voltage at pin2 of the comparator is set to low value than that of at the pin3 by implementing the circuit configuration. Therefore output pin7 stands with a 0V output and pin8 stands with a 5V output which is capable to switch on S3 and S6 switching MOSFETs. Thereafter, V1; -4.5V supply is connected to inverting input of 741 Op-Amp and non-inverting input has a zero voltage as S3 is in switched-on state.

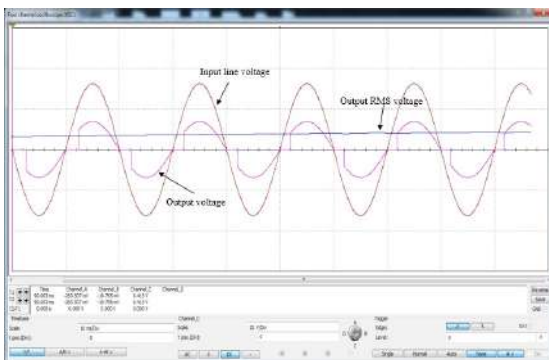
The voltage difference of these input pins is amplified by factor one and supplied to pulse generators. It is clear that at the initial stage, the voltage difference is  $0 - (-4.5V) = 4.5V$ .

This voltage is capable of creating pulses to fire-up back to back thyristors successfully. At the end of this initial time period, output feedback voltage has increased to a higher value than pre-set 3.4V at the pin3 of the comparator. Subsequently 5V and 0V outputs are generated at pin7 and pin8 respectively. As a consequent, MOSFET S9 and S11 are switched on, S3 and S6 (Previously on) are switched off instantly. Now, 741 OP-Amp is set with a negative output feedback voltage at pin2 and non-inverting input is set with an exponentially ramp signal.



**Figure 8. Circuit diagram for initiator and ramp generator**

The difference voltage will be amplified by the amplifier. Difference of input voltage is increased with time, i.e. the output voltage of OP-AMP is also increased with time. This ramp voltage is supplied to input of the pulse generator. The time gap of the pulses reduces so that firing angle of the thyristor increases. R10 and C4 generate exponentially increasing voltage which is set at pin3. By changing the values of the components we can adjust the settling time of the whole system comfortably. This exponentially increasing voltage is stabilized at a certain time according to capacitor charging equation. Subsequently, the output voltage of 741 OP-AMP becomes stable.



**Figure 9. Input and output voltage wave forms of the power converter**

Finally, the input voltage for pulse generators will also reach to a stable value by ensuring the stabilized final output. Waveforms shown in the Figure 9 witness that the supply voltage to thermal vacuum tube is in the form of AC input (standard power input) and the desired output voltage is formed in a way that, back to back thyristors are fired by varying the firing angles. Hence proposed converter technique has introduced a non-irregular closed loop controlled regulated power supply to the filament of the thermal vacuum tube.

#### ACKNOWLEDGMENT

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# AUTONOMOUS MOBILE ROBOT FOR DISEASE DETECTION AND INDIVIDUAL HEALTH MONITORING OF CATTLE IN INTENSIVE DAIRY FARMS

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**Abstract** - “Intensive farming methods” used in modern day dairy farms have resulted in a need for close monitoring of cattle health and early identification of diseases. The labour shortage faced by dairy industry, globally, has left farmers with no option but to go for automation. Current semi-automated systems used for cattle health monitoring, lack a non-invasive, real-time information system for individual health monitoring of cattle. As an attempt to address these issues, this research was done with the objective of finding out the suitability and feasibility of an “Autonomous Mobile Robot” to monitor cattle individually and update the stakeholders with real-time information.

The design of the system involved a robot, programmed to navigate from one cow to another while cattle are being fed in “feeding stations”. A visual-imaging camera and a thermographic camera were used as sensors to detect a set of physiological indicators corresponding to symptoms of popular cattle diseases. A “face recognition algorithm” was developed for cattle and images taken from both visual and thermographic cameras were processed to extract information about health condition of each cow.

The information would then be communicated to the herdsmen via internet on a real-time, simplex communication system. Sensors used were capable of detecting two different physical parameters, namely, red color on facial area and body temperature of cattle. The algorithms were simulated using real-world imagery. Detection rates obtained through simulations proved

the algorithms to be effective. Despite the high detection rates, some limitations which could hinder system performance such as poor barn conditions and inadequate system parameters were identified. However, as the barn conditions and design parameters could be modified and improved, the conclusion is that the mobile robot based system can fulfil the objectives of the research.

**Keywords** - Intensive farming, Mobile robot, individual monitoring, Real-time communication

## I. INTRODUCTION

Dairy industry has undergone revolutionary changes since the introduction of intensive farming methods in which the livestock is stocked at a high density inside barns, greatly replacing free grazing models that allow the animals to graze freely in open lands.

Cattle farms, traditionally were run by herdsmen who looked after a comparatively fewer number of cattle which allowed them to monitor each and every cattle individually. But with the embracement of intensive farming methods, compared to the number of herdsmen, the number of cattle accommodated in a barn has increased exponentially leaving the large herds to be looked after by a limited number of herdsmen.

Even though this growth in livestock has helped dairy farmers achieve economies of scale, it has exposed the farming operation to a number of risks and ethical implications. The risk of spread of diseases among cattle

is extremely high in these barns as they are packed within a confined space and therefore early identification of diseases is of utmost importance. However, with the severe labour shortage faced by the dairy industry, globally [2, 15], close monitoring of cattle by herdsmen has become impractical.

With the development of sensor technology, researchers have been looking for ways to answer this issue with the detection of symptoms of diseases automatically by monitoring the physiological and behavioural indicators of cattle with sensors. Use of Radio frequency identification (RFID) tags on each cow has made it possible to track down each and every cow precisely.

This has largely facilitated the use of sensor systems for monitoring cattle. The sensor systems currently used for this purpose can mainly be divided into two as stationary and mobile systems.

In stationary systems the sensors are placed at fixed locations in the barn. The rationale behind this is that the cattle in a barn have a repetitive daily routine and sensors can be fixed at locations where cows gather routinely (e.g.: Milking parlor, feeding station).

Typical stationary sensors include surveillance cameras, temperature sensors, disposable taste sensors, thermographic cameras etc. Requirement of only a few number of sensors and the relatively simple technology behind it are the main benefits of this approach. However the limited individual attention given to each cow is the main drawback of it. Also the barn conditions (e.g.: poor lighting) often limit the amount of useful information that can be extracted from the monitoring process [5].

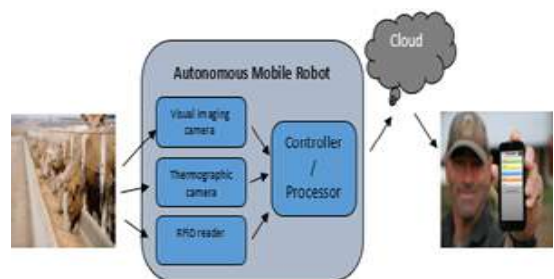
On the other hand mobile systems involve attaching the sensor to the cow's body or implanting the sensor inside the cow's body. Typical sensors include accelerometers, pedometers, GPS positioning sensors, pH sensors etc. This approach facilitates individual attention but mostly invasive in nature. The need for a large number of sensors, increases the initial capital investment. Also technologies like "GPS tracking" are more suitable for free-grazing models [7, 9].

Alongside with sensor technology, robotics technology has developed at a great pace over the last few decades. Areas such as industrial production processes, defense and military, entertainment, hospitality etc. have undergone

amazing technological advances due to robots. Compared to these fields the dairy industry hasn't experienced much involvement of robots inside the barn [11, 12]. Researchers have developed Auto-guided vehicles to automate the processes such as milking and feeding of cattle, manure removal and barn cleaning etc. [4]. However there is plenty of potential for development of robotics technology in the area of disease identification and health monitoring of cattle in dairy farms.

Hence this paper is based on research work done to find out the feasibility and suitability of using an autonomous mobile robot for early detection of cattle diseases and developing a real-time information system to keep the herdsmen informed about the health condition of cattle.

## II. METHODOLOGY



**Figure 01: Information flow of the developed system**

Development of the cattle health monitoring system can be divided into three main parts,

### a. Development of Autonomous Mobile Robot.

The series of tasks expected to be performed by the autonomous mobile robot are getting near each and every cow in the herd, getting readings for a set of detectable physical parameters from each cow, processing data and communicating the information to stakeholders.

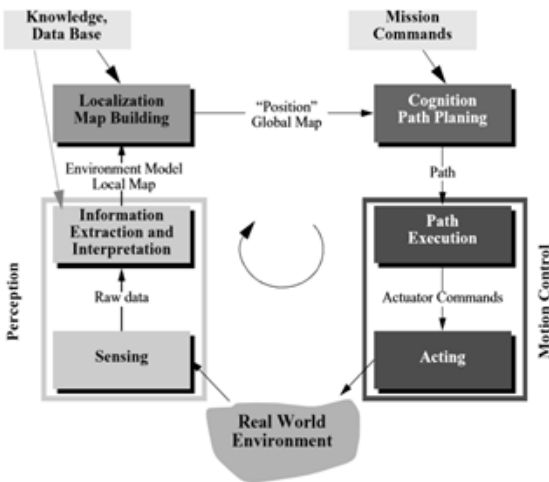


Figure 02: Reference control scheme for autonomous mobile robot [14]

The task of getting near each and every cow is simplified by the repetitive daily routine followed by cattle. “Feeding stations” are maintained inside barns to feed the livestock. These feeding stations are designed to prevent jostling or crowding. This provides an ideal opportunity for the mobile robot to get near cows without coming into direct contact with them. The robot can be programmed to navigate from one cow to the next on its own and to avoid unexpected obstacles such as farming equipment standing in its way. Feeding intervals provide enough time for the batteries which power up the robot to be re-charged. The non-invasive methods used to monitor the cattle are believed not to cause any distress or discomfort to the animals. The barn floor is often wet and slippery. And the feeding stations allow cattle to be monitored by the mobile robot with minimum changes to its orientation since the robot can navigate from one cow to the next with absolutely no change in its orientation unless it is disturbed by an obstacle. Therefore a Tracked-skid locomotion mechanism is used by the autonomous mobile robot to move around as it provides larger traction and increases manoeuvrability in the loose terrain. The robot is localized at the charging station where the batteries of the robot are charged prior to the cattle feeding session and is programmed to move to the first feeding slot at the beginning of the feeding period. The face of the cow is identified using an algorithm based on vibration. This is possible since the environment captured by the cameras is almost stationary except for the cattle being fed.

**b. Gathering data via sensors.**

Three types of sensors are attached to the end-effector, namely, visual imaging camera, thermographic camera and RFID reader. As the robot navigates in the feeding station the cows’ face is detected by the visual imaging camera using a face detection algorithm.

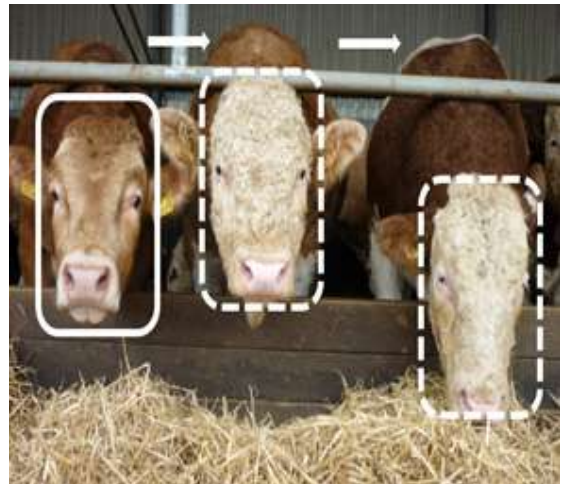


Figure 03: Detection and navigation sequence by the robot

Then the visual image of the face of each cow is sent to the processor to be processed to detect visual evidence for unusual blood patches or sore eyes. This is done using a technique known as digital image thresholding. The color image is converted to a binary image in search of red color. Using the same technique on a thermal image of the cow taken by the thermographic camera can be used to detect high temperature of the whole body or individual body parts of the cow.

The RFID reader is used to identify each and every cow separately by transmitting a radio frequency signal to the RFID tag and receiving back the signal with information about cow’s identity.

**c. Communicating data to the stakeholders.**

In order to realize the full use of the system, the information processed should immediately be communicated to the herdsmen. This is facilitated by wire-less communication between the robot and the herdsmen. A Wi-Fi module connected to the controller provides access to internet via Wi-Fi signals energized by a router in the barn.



In case a disease symptom is detected by the robot, the herdsmen will be immediately warned along with the information about potential diseases the detected cow may be suffering, via a phone app designed for this application. The data gathered will also be stored using the cloud technology which is becoming increasingly popular in dairy industry with the new concept of big data [8] which facilitates the long term health monitoring of the herd.

### III. RESULTS AND DISCUSSION

The system developed was expected to detect two different parameters related to cattle health. They were,

- Red color on the visual image of the face.
- Body temperature beyond 39.50C.

(Average body temperature of a healthy cow: 38.50C) [1] These parameters correspond to symptoms of some of the most common cattle diseases in dairy industry such as “mastitis”, “infectus rhinotracheitis” (red nose infection), “epistaxis” (bloody nose), “bovine babesiosis” (tick fever) etc. [3, 6, 13].

Real-world images of 20 cows suffering from bloody nose, red nose infection and sore eyes and 20 images from healthy cows were simulated on software with a developed digital image thresholding program to find out the effectiveness of disease detection process. 15 of the diseased cows were correctly identified and 5 were overlooked due to inadequacy of red color in the image, poor contrast and poor brightness/ Lighting conditions (Detection rate: 75%). 18 of healthy cows were correctly identified and 2 were affected by noise (Detection rate: 90%).



Figure 04: Visual image and processed binary image

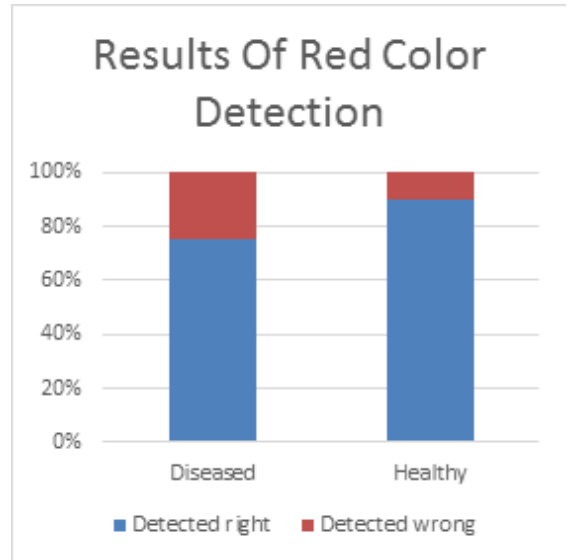


Figure 05: Results of red color detection

In this system the robot is programmed to get near cattle while they are being fed. Even though, this way, the chances of robot or cattle meeting with accidents by coming into contact with each other are minimized, monitoring cattle only in the feeding station, limits the amount of information gathered. For example, to detect the temperature of the cow’s udder properly, a thermal image covering a significant part of the udder should be taken. But with the current model of taking readings at the feeding station, the angular range of coverage of each cow is limited since the feeding stations are designed with little gap between two adjacent cows. This problem can be solved to an extent by increasing the degree of freedom of the robot. However a better solution identified was to re-design the robot to take information during the milking sessions, which is expected to be done in future.

The details of the potential diseases (found by matching the diseases to the symptom/s detected) would be sent to the herdsmen along with the symptoms detected, detection time and the identity of the cow, as the main output of the system. This is expected to initiate prompt action by the herdsmen and give them a heads-up about the potential issue ahead of them (e.g.: what type of disease it could be and what kind of action needs to be taken based on their intuition). However the number of diseases which could be detected are limited by the number of symptoms that could be used on the robot. A bunch of more sensors

would increase the scope of the robot as far as disease identification is concerned. However this will increase the time spent on each cow, which is around 1 minute with the current system. Also the “processor speed” and “data communication speed” requirements will be major concerns.

During simulations of the initial design of the system developed, one major constrain identified was the limited space of the domain in which the mobile robot had to work. This was due to the limited range of the Wi-Fi router. This made the system ineffective to be used in large intensive farms with many thousands of cattle. However using “Wi-Fi boosters and extenders” the range could be increased significantly.

Since the robot uses a visual camera for its monitoring, the lighting conditions of images taken in the barn were proven to have a significant impact on the final outcome, during simulations. Attaching a flash-light along with the lighting conditions cannot be accepted since it could cause distress or discomfort to the cattle that can affect its routine activities.

The time taken by the robot to monitor one cow is around 1 minute. This can be a limitation when it comes to large herds. The state-of-art navigation system, which is known as “vertical take-off and landing drones” could be used to perform many of the tasks performed by this system within a very shorter period of time. However the biggest challenge in doing so is the limited range of RFID sensors. It is expected to overcome this issue as an extension to this research.

## IV. CONCLUSION

Since intensive dairy farming methods are highly prone to quick spread of diseases among the herd, regular close monitoring of each cattle is of utmost importance. However with the labor shortage faced by the dairy industry all over the globe, automation of processes can be considered the best alternative. The Autonomous Mobile Robot based system for health monitoring and disease identification of cattle, not only allows the process of monitoring cattle to be automated but also builds a platform for the herdsmen to react immediately and to maintain long term records about the health conditions of the herd which facilitates effective health monitoring of the cattle in intensive dairy farms.

On the other hand, the robotics and communication technologies used in this research are less sophisticated. Most of the technologies used have already proven to work with similar applications in different fields. Therefore based on this research it can be stated that an autonomous mobile robot is suitable and feasible to be used for early detection of cattle diseases and development of a real-time information system to keep the farm managers informed about the health condition of cattle in an intensive dairy farm.

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# SMART HOSPITAL WARD MANAGEMENT SYSTEM WITH MOBILE ROBOT WARDBOT: AN EFFICIENT MANAGEMENT SOLUTION FOR HOSPITAL WARD

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**Abstract** - The hospital ward system is one of the major section of the hospital. Various ward management systems are used by hospital staff in order to maintain the system. This paper presents a novel concept of, Smart Hospital Ward Management System (SHWMS) based on mobile robotic platform (WARDBOT) for a public hospital ward in Sri Lanka. The need of a smart system combined with an assisting robot for performing activities in the public hospital system is great importance for doctors, nurses, patients and other healthcare assistances due to excess work load and limited work force. The Aim of this research is to provide efficient and effective solution for the drawbacks of ward management, patient monitoring, interacting, drug distributing, specimen collecting and ward preparation processes with the help of SHWMS and WARDBOT.

**Keywords** - smart hospital ward management system, mobile robot platform, drug distribution, patient monitoring, specimen collecting.

## I. INTRODUCTION

Hospital ward system is a complex co-domain of hospital system. Involvement of doctors, nurses, other healthcare assistances fulfil the requirements of the patients in the hospital ward system. Interaction between further mentioned personals help to maintain the smooth run of the ward system.

Doctors' tasks also include making a diagnosis and treatment plans for the patients in the ward, taking history of newly admitted patients, requesting laboratory results or radiological findings, making discharge notes and prescribing medicine and taking responsibilities of medical students and interns. Therefore, more responsibilities of ward management are done by the nurses.

Nurses play a major role in the hospital ward. Their role can be summarized as a caretaker, client advocator, collaborator, communicator, health educator and as well as a researcher. The responsibility of a nurse as a caretaker is to improve the state of physical, emotional, social and spiritual wellbeing of the patient and to restore and promote the health status. As a collaborator, the nurse should collaborate with the patient, his/her family and other multidisciplinary health care teams to meet the health care needs of the patient. It is the role of the nurse to support the other health care professionals to identify the critical needs of the patient. Finally, as an educator and a researcher, a nurse has enormous duties within the hospital. (Basawanthappa,2009). Admission is a process in which an individual is entered into a health care agency for medical or surgical treatment and nursing care. There are two types of admission processes: inpatient and outpatient admission. In, inpatient admission a patient's length of stay in the ward is more than 24 hours and vice versa. Whether it is inpatient or outpatient the main purposes of patient admission is for treatment, investigation, illness

prevention and health promotion. (Potter, P.A., & Perry, A.G., 2011). Nurses assist the patient to adapt to the hospital environment, initiate effective nurse - patient relationship, relieve the anxiety of the patient and the family, develop a data base for individualized care plan and build patient's trust towards the institution. Several documents have to be maintained by the nurses as part of their duty such as the admission book, Bed Head Ticket (BHT), temperature chart, observation chart, intake - output chart, Capillary Blood Sugar chart (CBS), treatment sheets, diagnostic cards, drug chart etc.

These documents have a legal value. Therefore, it's necessary to maintain these within a hospital ward system. Medicine management and distribution is one of the key responsibilities of a ward nurse. There are protocols for storage of medicine, especially for narcotics and controlled substances. Under responsibilities of medication administration, nurses are legally responsible for the safe and accurate administration of medication, having sufficient drug knowledge to recognize and answer the patient's question, to confirm "six rights" of safe medication administration and follow "three checks". (Fry S., & Johnston, M.J. 2008). Patient monitoring is a very important duty in a ward. That duty is done by a nurse. Also, monitoring present conditions of patients like hygienic level, level of saline, level of urine etc. is to be done by a nurse. Vital sign monitoring is a procedure that takes signs of basic physiology including temperature, pulse, respiration and blood pressure. Purpose of the vital sign measuring is to assess patient's conditions, to determine baseline value for future comparisons and to detect changes or abnormalities of the patient and to evaluate his/her recovery from illness. This should be done with care as this data is referred by the doctor for diagnostic purposes. Specimen collecting, labelling and transporting are some of the duties carried out by a nurse. Under specimen collecting, blood and urine collection is very common. Nurses collect blood for blood culture before administering antibiotics. They collect blood to a clean bottle with an infusion broth. The best time for collecting blood for blood culture is when the patient is having fever spikes, chills/rigors. Ideally urine is sterile. Nurses advise the patients to collect urine early in the morning before administering antibiotics and to refrain from passing urine until the specimens are collected. Sterile, dry, wide necked, leak proof containers are used for collecting urine. When transporting specimen, it should be properly labelled with the patient's name, BHT no, name of the specimen and the ward number. (Bavin C., Cole E., Hunter J., 2012).

A Sri Lankan health-care delivery review revealed that limited no. of qualified nurses exists in many hospitals and medical institutions. Due to poor working conditions like lack of resources, busy work environment, poor infrastructure, an inadequate salary, lesser exposure to technology, lack of specialized education and limited carrier reconnaissance are the reasons for poor quality of patient care (Badurakada & Colleen, 2010). Therefore, outcomes of the above-mentioned duties are not up to standard. Documentation process of the hospital ward system has many draw backs due to inefficient method of data entering and retrieving. Therefore, level of reliability of the process is poor. Overcrowded patients, stressed out workers, single data entering facility are the main reasons for this. Medicine management and distribution within the present hospital ward systems has its own cons due to poor documentation system and excess number of patients. Medical negligence can occur due to these reasons. (Landmark Case of Medical Negligence in Sri Lanka, 2002) because of that it's risky for patients' lives. (Landmark Case of Medical Negligence in Sri Lanka, 2002) Also in the sense of drug distribution, two nurses spend nearly one or one and half hours to distribute the necessary drugs (Badurakada & Colleen, 2010). Therefore, due to these kinds of working situations, nurses limit the patient caring time and interaction time (Badurakada & Colleen, 2010). That results in reduction of physical, mental and social health of the patients. In Sri Lanka, due to excess work load and limited resources nurses have to work under pressure in the patient monitoring process. Generally, 75-85 patients are available (Badurakada & Colleen, 2010) in a ward but only 5 or 6 nurses are assigned on duty shift (Badurakada & Colleen, 2010). Deficiency of proper equipment, unreliable methods of measuring vital signs and monitoring patient condition cause an avalanche influence in diagnosing diseases.

To find solutions for the above-mentioned drawbacks in the hospital ward system knowledge of robotics, computer science, mechatronics engineering and medicine were used. Concept of Smart Hospital Ward Management System (SHWMS) based on mobile robotic platform (WARDBOT) is implemented to increase the efficiency and reliability in the hospital ward system by implementing smart database management system, drug distribution system, low cost non-contacting vital sign monitoring system, patient condition monitoring system, specimen collecting, labelling and transporting system, ward preparation and maintaining system.

Throughout this research, smart hospital ward management system and drug distribution system are mainly discussed and other systems will be discussed in future researches.

## II. LITERATURE SURVEY

Continuous development of computer science, mechatronics and robotics and the applications based on synchronization of these three fields have been widely expanded. Impact of robotics in military, space, manufacturing and health-care applications brought huge success due to reliability, durability and effectivity. Nowadays different types of robotic technologies are used based on these applications. The shortage of healthcare staff has been a massive problem over the past decades in the world. Hospitals are overcrowded with patients, lack of resources, huge responsibility on nurses and staff has been highlighted in developing countries like Sri Lanka.

Therefore researches, scientists and engineers search different solutions for this issue. Usage of robotics is one of the most successful approach. Development of the mobile robotics, researches have showed its success in the hospital environment. In 1985 Koren et al. (Johann & Yoram, 1985) described the mobile platform for a nursing robot. The iWARD (Mamun, Sharma, Hoque, & Szecsi, 2014) is a nursing robot. It is an intelligent system for patient monitoring, cleaning and delivering within a mobile platform. Care-o-bot (Hans, Graf, & Schraft) and Skillgent (Healthcare/Eldercare Robot based on Skillgent, 2017) are servicing robots which can be used for home and hospital environment. Care-o-bot and Skillgent (Healthcare/Eldercare Robot based on Skillgent, 2017) are not capable of interchanging their service units. They are manufactured with onboard features. Also, those robots can't communicate in the ward network or connect to the ward server. iWARD (Mamun, Sharma, Hoque, & Szecsi, 2014) robots have interchangeable service units but those units are separately controlled. These methods are not suitable for hospitals which allocates a separate time for each separate task. This method is not cost effective in developing countries because each and every unit needs a separate control system and power supply. Also in that system, they use sensor belts for each and every patient in vital sign monitoring purpose. That is an impractical concept for patients who has serious injuries and problems. Therefore, mobile robot with non-contacting vital sign measuring system is important in practical usage. It affects the overhead cost because vital signs are not monitored continuously in a hospital ward system. Cao et al. (Cao,

Fukunaga A, & Khang A, 1997) categorized different architectures in the cooperative, multi-robot domain. Attempts have also been taken to analytically determine the minimum information required for solving a task (Donald, 1995) and for automatic generation of robot teams (Parker, 1998). However most of these attempts have not succeed the issues of distributed collaborative behaviour and distribution of resources across robots. Presently, self-navigating mobile robots have been used in many hospital systems (Ambrose & Askew, 1995) (Hayes, Martinoli, & Goodman, 2002) (Monkman & Taylor, 1993) (Shieh, Hsieh, & Cheng, 2004) (Takahashi, Suzuki, Cinquegrani, Sorbello, & Pagello, 2009). But the problem is that there is no point of using self-navigating robots for a properly mapped location. Therefore, mechanism to avoid obstacles and stopping is enough for these applications. If not it will be a resource wasting and power consuming activity. If we consider that beds are stable and patients are static, magnetic track guiding method is more reliable and quick.

Hospital ward management system is an essential computer based system for a hospital ward system. Database management, wireless networking are the key features of this system. According to Paul Vegoda (1987), hospital Information management system as an integrated information system which helps to improve the patient care by uplifting the user's knowledge and uncertainty allowing rational decisions to be made for the information provided. With the help of different software that are integrated in order to capture data in specific sections, helps to handle the work flow of the daily routine of medical staff and it also helps to keep administrative and clinical data up to date (Garrido, Raymond, Ling and Wiesenthal, 2004). Computerized database is necessary because it is hard to maintain huge amounts of paper work, and there is no backup of those documents and access to information is difficult and consume fair amount of time when referring. (Adebayo A., 2014). Therefore, we can see that the system integration is required to have a proper organized database of patients' details.

Providing IT tools to health care professionals will help their daily activities. Mostly doctors and nurses do not have easy access to patients' records when they work at "bedside" and information is mostly recorded on paper and subsequently transliterated on paper for further processing (E. Cosacia, G. Dodero, S. Virtuso, V. Gianuzzi, 2012). Paper recording has been an issue when it comes to sharing information, retrieving information and storing information. Manual paper documentation takes

a lot of space and time for data processing. Therefore, importance of computer based database management system is highlighted. The hospital information system is the complete information processing and information storage subsystem of a hospital, whereby it is not just about computer systems and networks and the computer-based application systems that are installed on them. But it encompasses all the information of the hospital. (B. Premakumar, K. Kalpana, 2013). Hospital database management is a huge area as it fulfils the services of different departments and personnel of a hospital.

Drug distribution is a very important process in a hospital ward. Several researches were carried out for the areas of drug dispensing and drug distribution. Karat and Jackrit (Karat & Jackrit, 2014) proposed a system for drug distribution among hospital wards via automated guided vehicles but their proposed system didn't touch the area of drug distribution among patients and nurses. Evaluations of automatic drug dispensing systems were done by Fitzpatrick et al (Fitzpatrick, Cooke, Southall, Kauldhar, & Waters, 2005) and Chapuis et al (Claire Chapuis, et al., 2010). Sakine et al (Sakine & Abdulsamet, 2015) described a system but that was based on voice commands of the nurse. Drawbacks can occur in that system due to busy and noisy environment of the hospital ward. Therefore, accuracy of the voice command cannot be guaranteed in risky and populated situations.

### III. SMART HOSPITAL WARD MANAGEMENT SYSTEM

Concept of SHWMS is based on database management system, Smart mobile application and wireless network. Requirement of database defers from person to person who works in a hospital. Receptionist of the hospital system needs to take information of the patient. Therefore, requirements of the receptionist can be considered as: login to database, register patient, view patient record, search for past records and edit patient records. After getting registered, a nurse will take care of the patient. Nurse also needs to access the database for several activities: login to database, view patient's records, search for records, assign patient to ward and assign a bed to patient and upload daily readings of patient's health.

After these, the doctor checks the patient and needs to: login to database, view patient's record, upload patient diagnosis summary, search for history records of patient and upload prescription

In order to full fill above requirements, a database have to be designed in a particular manner where all the patients' records are kept in an organized, easily updatable and searchable manner. For that, a database is designed using MySQL. In that different types of tables are made for gathering admission information, drug charts, treatment information, different health parameters and lab test reports. The interconnection among tables is made through Patient's ID which is given by the system.

To communicate with MySQL database, A web based interface is designed and that includes each and every form that the hospital needs to keep records of. Forms are linked to the database from PHP. HTTP protocol allows to update and view the data from the database easily. To access the database (by using HTTP protocol), tablet devices are given to each nurse and doctor in the ward with a login ID.

Privilege level is given to the system based on profession. As an example, prescription only can be updated by doctor and automatically updated drug chart can be viewed only by nurse. Tablets are supplied to wards and to communicate with the server there is a Local Area Network in the ward which allows communication among tablets, with the database server and with WARDBOT.

There are wireless access points fixed in the ward to give wireless connectivity to the devices to login to the server. Access points are connected to a switch which will enable the connection between server and the access points. When Someone needs to work with the web application he/she can just type the Server IP and get access but for someone without a IT literacy is an issue. Therefore, Domain Name System (DNS) is used to make URL access easy. Server IP is given a domain name (ex: xxxxx.com) by DNS and using that staff can access the web app. Tablet devices communicate with server through web application which got a back end written from PHP. To communicate with robot, Python program with PHP plugins were used. The ward server is connected to the Hospital webservice in the Hospital website. Therefore, Doctors get the access to see the patient records from remote access capability.

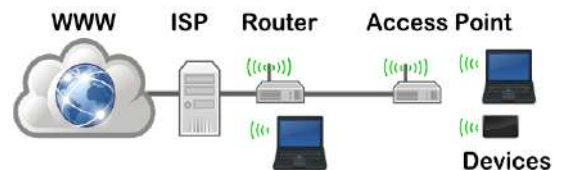


Figure 1. Web Interface example

To control the WARDBOT, nurses need to be signed in. then he/she can access the WARDBOT’s controls such as drugs distribution, specimen collecting, ward preparation, patient monitoring.

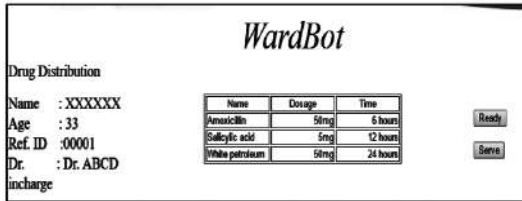


Figure 2. Network Architecture

When a nurse is logged in to WARDBOT tab, he/she will get options to select the task. As an example, when he/she clicks on drug distribution, the search form will appear (which can be used to select the patient) the app shows the patient’s medicine that has been prescribed by the doctor. Finally, the nurse has to give command to fetch the medicine.

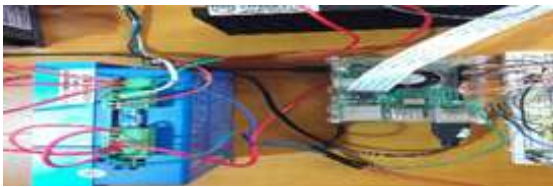


Figure 3.

#### IV. MOBILE ROBOT: WARDBOT

WARDBOT: Mobile robot design shows the importance of main robot unit and subordinate robot units for different applications. This design provides easy configuration, easy expansion, optimizable and economical solution for the hospital wards of developing countries.

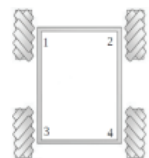
WARDBOT comprises of no. of control units, each provides a distinct function, contributing to the overall task. The main robotic unit consists of a main control unit and a 6 degree of freedom robotic arm and it is controlled by an industrial computer with touch screen display and a Linux operating system. Along with it a secondary processing unit of single board computer “Raspberry Pi 3B” (R-Pi) is attached to do the processing for magnetic track guiding, obstacles detecting and avoiding for navigation. Other subordinate robot units for other applications can be connected automatically with the nurses’ command.

#### A Main Mobile Robot Unit: Mobile platform

Main mobile robot unit is the heart of WARDBOT. Magnetic track guiding method is used as the navigation method of the robot. A magnetic guide sensor detects and reports the position of a magnetic field on the horizontal axis, for the movement of robots on the ward floor. In the design, we used adhesive magnetic tape for the floor-level track which can be followed by the robot. Advanced signal processing accurately measures lateral distance from the track’s centre, from a height up to 60mm. The magnetic guide sensor (MGS1600) of “RoboteQ” (Building a Magnetic Track Guided AGV, 2013) provides a position resolution of 1mm. Compared to optical track guiding method, magnetic track guiding method is very reliable because hospital environments are full of dirt and with varying light conditions. MGS1600 sensor has an inbuilt USB port. Therefore, it is capable of connecting with R-Pi. Then R-Pi processes it is using python and sends relevant commands to the motor controllers via CAN-bus protocol.

In here, 4 “Mecanum” wheels are used to drive the unit and to bear up the weight and for the ease of handling in connecting the main unit to the trolley (rather than using two-wheel drive with castor wheels). “Mecanum” drive is a type of holonomic drive base which can apply the force of the wheel at a 45° angle to the robot instead of on one of its axes. By applying the force at an angle to the robot, magnitude of the force vectors to gain translational control of the robot can be varied. In the sense of controlling “Mecanum” drive needs angle, magnitude and rotation.

$V_x$ =The voltage multiplier for the  $x^{th}$  wheel  
 $V_d$ =Desired robot speed [-1,1]  
 $\theta_d$ =Desired robot angle [0,2 $\pi$ ]  
 $V_\theta$ =Desired speed for changing direction



$$V_x = V_d \sin(\theta_d + \frac{\pi}{4}) \pm V_\theta \tag{1}$$

Figure 4. Wheel Numbering

Four DC brushless geared motors were used with two “HBL2360” motor controllers (Brushless DC Motor Controllers : HBL2360, n.d.). These two dual channel controllers are connected with CAN-bus protocol to operate it as a single four-channel drive. One driver is served as a master and other as slave. Then master is controlled via R-Pi. MaxBotix USB ultrasonic sensors (MB7363) is used for the object detection and stopping purpose of the mobile robot. That is capable of connecting



to the R-Pi through a USB port. Therefore true/false output from the sensor makes an easy processing in R-Pi.

Power for the mobile robot unit is given by a valve regulated lead-acid battery pack. Valve regulated lead acid batteries are ideal for hospital environments where cleanliness is important and gassing is not permitted. There is no watering or special equalized charging needed for the life of the battery under normal conditions. Automatic battery swap out charging method is used due to the busy hospital environment. This method allows the mobile robot to operate for about 12 hours and up to 5 to 10 minutes of down time for the battery replacement procedure. (AGV Kennis Instituut, n.d.)

### B Main Mobile Robot Unit: 6DOF Robotic Arm

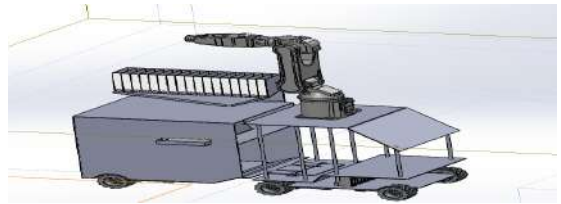
Robotic arm consisted with waist, shoulder, elbow, wrist and end-effector. Six joints were named X, Y, Z and A, B, C. Separate six servo motors were used with harmonic drives and Mesa card to control the motion of the robotic arm. The Mesa card (7196) is an ethernet connected motion control interface designed for interfacing step and direction of servo motor drives and TTL inputs and outputs of the system.

Robotic manipulator and the control system was designed but end-effector of the robotic arm was decided to use an industrially available one. 3-finger adaptive gripper of RobotiQ (3-Finger Adaptive Robot Gripper - Robotiq, n.d.) was selected for the whole research and for this research, end effector with camera and vacuum head was designed.

As an operating system customizability of Linux, can be considered as an optimum solution for this application. Special software called "Linux CNC" was used as the controlling application of the manipulator. According to "Linux CNC", there are main two types of file systems. INI and HAL. INI files are generally used by "Linux CNC" to store their individual settings. Hardware Abstraction Layer (HAL) files are type of files which allows a computer operating system to interact with hardware devices at a general or abstract level rather than at a detailed hardware level. The hardware abstraction layer can be called from either the operating system's kernel or from a device driver. Robotic manipulator was configured by referring to the INI and HAL files of "PUMA 560" (Puma560, n.d.). The kinematics is provided in LinuxCNC by a specially written component in the C language. This can be used in HAL file. Inverse kinematics is used in some applications of this research.

### C Subordinate Mobile Robot Unit: Drug Distribution

Subordinate units are used in this research to connect various service units to the main mobile robot unit. Drug distribution is one the major task in the hospital ward system. In this research, an effective method was implemented for that.



*Figure 5. Robotic Arm with Drug Distribution unit*

When a nurse wants to provide medicine for patients in a ward, she uses the given tab to command the robot to do the task. If the main unit in the robot is available for use, it sends a signal back to the tab informing that it is getting ready for operation. After that the main unit connects the drug distribution unit to it and the combined unit goes from patient to patient with the nurse in order of patient number. This mechanism is navigated by track guiding and object avoiding mechanism.

By the patient ID, the PC of main unit accesses the ward database and retrieves data related to that particular patient. Then the medicine which was prescribed by the doctor is indicated by a LED in the relevant dispensers for the particular patient. Then nurse should confirm the medicine with the information given by the database using the tab. When the confirmed signal is received by the unit, it dispenses the tablets and capsules.

According to the nurses' responsibilities, nurses should follow "three checks" in medicine distribution. Our system is designed according to these regulations. Therefore, in our system 1st check is covered in medicine uploading (to containers) moment as 1st confirmation in the mobile application. Then 2nd check is covered in 2nd confirmation of the mobile application and 3rd check is covered in final confirmation.

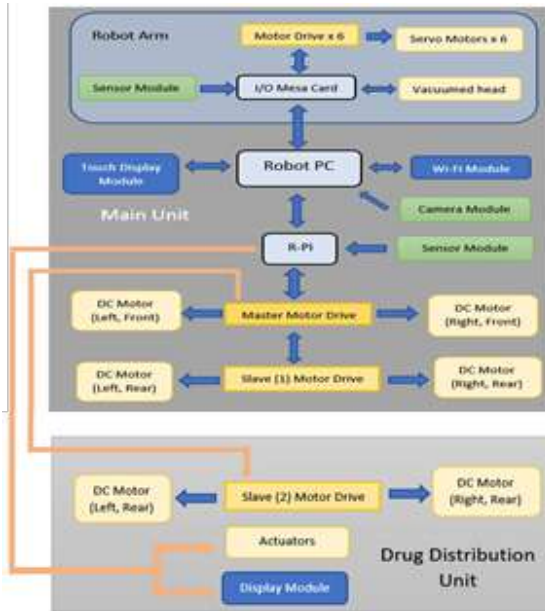


Figure 6. Main Structure

If syrups are prescribed, the camera in the arm focuses on the rack of syrups, and then the syrup is picked by the arm. For this application inverse kinematics is used in the robotic arm. By using inverse kinematics joint angles can be generated with the help of co-ordinates. In this research, we used simple technique to identify relevant syrup according to prescription. According to the system all the syrups are numbered and given a QR code. That code is printed and pasted on the cap of the syrup bottle. Then those syrup bottles are placed in a rack. That rack locates in a permanent place and fixed position is given (above the rack) to the robotic arm to move when signal is given. Then it generates real co-ordinates with the help of laser triangulation sensor “MicroTrak 4”. Finally picks the relevant syrup bottle.

For the above process, PHP-python plugin is used to crosslink PHP with python then OpenCV (OpenCV library, n.d.) library and QR code identification algorithms are used in python programming language to do the image processing and generate co-ordinates.

## V. TEST, RESULT AND ANALYSIS

The testing of the SHWMS and WARDBOT were basically focused on hardware and software functionality.

### A. Smart Hospital Ward Management System

Initially wireless network implementation was tested with the help of user interfaces of the system. Network simulation software called Cisco Packet Tracer [22] was used to check the accuracy of the network configuration. Then results were checked using the simulation tab. Collisions were not monitored therefore simulation became successful. Finally, network was built with the help of actual components and tested its’ reliability and accuracy during the run time.

User interface was tested with the help of 30 users and their positive feedback was recorded as 83.3%.

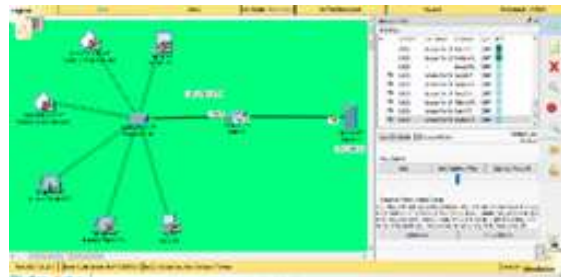


Figure 7. Packet Tracer Simulation and Web App Testing

### B. Mobile Robot: WARDBOT

The main unit and subordinate units were separately tested through software simulation tools. Some models of mechanical structures were built in order to test.

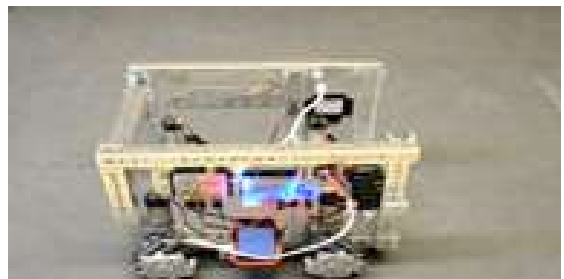


Figure 8. Physical Model Testing after V-Rep Simulation

Controlling of the units were simulated in V-Rep Pro Edu (Coppelia Robotics V-REP: Create. Compose. Simulate. Any Robot., n.d.) based on Kuka youBot and animated it in Solidworks. Only the Mecanum wheel base structure was physically tested.

Finally, consumed time for the application was taken in order to do analysis.

### C. DISCUSSION

Table 1. Shifts

Shift	No. of Nurses	No. of (h)
Morning	7	6
Evening	5	6
Night	2	12

Table 2. Test Results

Action	Consumed time(s)
For patients	3771 (65X58)
Travelling	290
Total Time	4061

Each shift has a drug distribution process; consumed time for drug distribution is 90 minutes. Two nurses are allocated for the duty. No. of patients in the ward is 58 (Badurakada & Colleen, 2010)

Drug delivering time for patients in present system is 5400 seconds and drug delivering time for patients in automated system is 3771 seconds. Finally, total time difference is 1629sec (27 minutes). Time consumed for drug distribution for two nurses is 10,800 seconds and time consumed for automated system for one nurse is 3,771 seconds. Therefore, in automated system time of 90 minutes for one nurse and 27 minutes of another nurse can be cancelled. Finally, total gain of the system can be increased from 2 hours. Therefore, automated system is 65.08% efficient than manual system.

### VI. CONCLUSION

This research proved the concept and implementation of reliable and efficient method for hospital ward. The overall system is also effective in terms of performance and cost due to multipurpose implementation and customizable feature.

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# AYURVEDIC PULSE DIAGNOSTIC TECHNIQUES TO DEVELOP MODERN NON-INVASIVE DISEASE DIAGNOSTIC DEVICES

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**Abstract** - Ayurvedic medicine is an oriental deep medical science based on the unique concept of the tridosha, namely Vata, Pitta, Kapha. According to the Ayurvedic medicine, Vedic medical science is disease diagnosis by pulse analysis. However, the diagnosis is subjective and the accuracy depends on the experience and practice of the Ayurvedic practitioner.

Thus, researches can be carried out to find solutions for subjective errors and increase the accuracy. Some of the currently conducted researches show optimistic results where the results of Ayurvedic practitioner's diagnosis and the results gives from the electronic device tally with each other. Subsequently, non-invasive diagnostic devices can be developed with the help of modern electronics and mathematical algorithms with reduced cost and time for the diagnosis. Moreover, it might become a good approach to protect the declining valuable techniques of Ayurvedic medicine. .

**Keywords** - Ayurvedic Medicine, Pulse Analysis, Non-invasive Diagnostic Devices

This is a review article based on the Ayurvedic pulse diagnostic technique which can be studied thoroughly to develop non-invasive low cost diagnostic devices. Aim of this article is to arise the need of non-invasive low cost diagnostic devices and suggesting fusion of wrist pulse analysis used in Ayurvedic medicine and modern electronics as a solution to fulfil the need.

## 1.0 Introduction to Ayurvedic Medicine

Ayurvedic medicine is an impressive and unique medical science originated in ancient India which is being used for both in diagnostics and treatments (Walia & Singh, 2010). "Prakrati Nidana", the characteristics of individuals such as body size, hair, weight, appetite, skin etc is the base of Ayurvedic medicine. (Joshi, 2005).

There are two main purposes in Ayurvedic Medicine. Maintain good health by prevention and cure diseases by appropriate diet, lifestyle, panchakarma and rejuvenation are the two main purposes of Ayurvedic medicine (Vaidya et al., 2015). Every living being is made of five elements correspond to the five senses in human. Earth/ Prithvi, water/ Apa, fire/ Tejas, Air/ Vayu and space/ Akash correspond to smell, taste, sight, touch and hearing respectively. Vata, Pitta, Kapha, the primary life forces or doshas made of above mentioned elements correspond to energy of movement, energy of digestion or metabolism and the energy of lubrication and structure in turn (Walia & Singh, 2010 & Joshi, 2005). Every cell in human contains single dosha or combination of two or three doshas which is unique to each individual. This concept of tridosha recognized as the foundation of Ayurvedic medicine represents the humeral balance. Dosha type of a person is determined by the domainting type of tridosha of that particular person and his characteristics depends accordingly. (Walia & Singh, 2010). Nadi Vijnanam is one of the important diagnostic methods used in Ayurvedic medicine. Nadi refers to pulse in vein and arteries.

Vijnanam refers to examination and understanding pulses (Joshi, 2005). Characteristics of the pulse waves depends on the blood flow. As blood flows throughout the body, even to the cellular level, that is a very good perception to disease diagnostics (Patil et al.,2015). Perfect early diagnostics either physical or mental could be made by the ancient ayurvedic expertise by examine the pulse patterns in specific points of the body and in some cases they have predicted the date and time of the death. (Joshi, 2005).

### 2.0 Pulse Analysis based Diagnosis

There are nine prominent points as shown in figure 1 is used for pulse examination by using one or more of three central finger tips of the practitioner. Radial artery sensation or wrist pulse analysis known as fivanadi is the most common technique of wrist pulse analysis (Joshi, 2005). Radial pulse of the patient at radial fossa is examined

with slightly pressed three middle finger tips of right hand of the Ayurvedic practitioner while supporting the patient's hand with his left hand as shown in figure 2 (Patil et al., 2015). Throbbing nature of the pulse is observed mentally by the practitioner. Vata is observed by the first index finger tip, pitta is observed by the middle finger tip and kapha is observed by the third (ring) fingertip (Walia & Singh, 2010). The right hand pulse is sensed in men and left hand pulse is sensed in female (Uebaba et al. 1993).

According to the internal biochemical and physiological functions, there are hundreds of different nadi patterns. Thus, both qualitative analysis and quantitative analysis are important in pulse analysis. Moreover, the variations of the levels of tridosha leads to the different patterns of pulse according to amplitude, rate, rhythm, shape, regularity and hardness. High levels of Vata, Pitta, Kapha manifest a snake's curved scrawling, frog's jump and swan's smooth slow rhythm respectively as shown in figure 3 (Joshi, 2005).

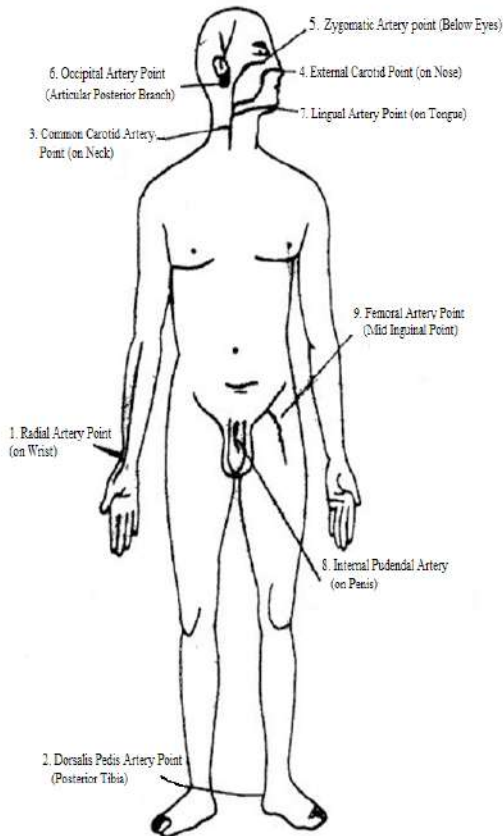


Figure 1. Nine prominent points of the body where pulse can be sensed.

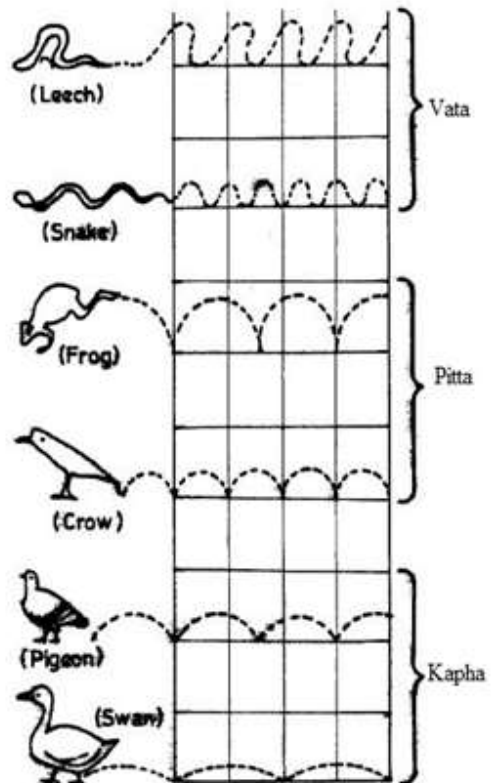


Figure 3. Different patterns of pulse according to the Ayurvedic medicine.

The most important parameters in pulse analysis are pulse amplitude which is the distance from the rest position to a point of the signal and the pulse rate which is the number of pulse signals occur per minute. To measure the pulse rate with the help of modern technologies, peak detection algorithm can be used.

Dhatu are the seven levels of radial pulse readings which are laid in-between the superficial layer and the inner core of body. According to the pressure applied on radial artery the level of pulse sensing is changed. These levels elaborate more details about the sub types of doshas, status of prana, theja, ojus and conditions of seven tissue levels. For examples, first layer or the superficial layer is called rasa dhatu and capillary layer is called raktha dhatu. Sensing the first layer is Vikurti. It indicates the current health condition of the person. Seventh layer is the deepest level where obliterate pulse is sensed. It is known as prakruti and contains details about basic constitution of the person. For a healthy person, prakruti and vikruti levels are equal (Lad, 1996).

### 3.0 Inaccuracy of Manual Pulse Reading

The pulse readings can be inaccurate due to erroneous finger positioning. Accurate reading can be obtained only if the three fingers are placed at same level. Moreover, any throb may not be felt if the index finger is placed directly on radial tubercle. A thick subcutaneous fat layer can interrupt the sensation of the pulse too.

In addition, premature births and umbilical strangulation also affect the pulse of a person from the birth. Thus, questioning the patient is important. Probably the accuracy depends on persistent and pro-longed practice. Ayurvedic practitioners use their own unique techniques developed with the clinical practice for pulse analysis. (Lad, 1996).

### 4.0 Electronic Devices for Pulse Analysis

There are prototype designs which have been developed during several researches to diagnostic purposes according to Ayurvedic medicine by pulse analysis.

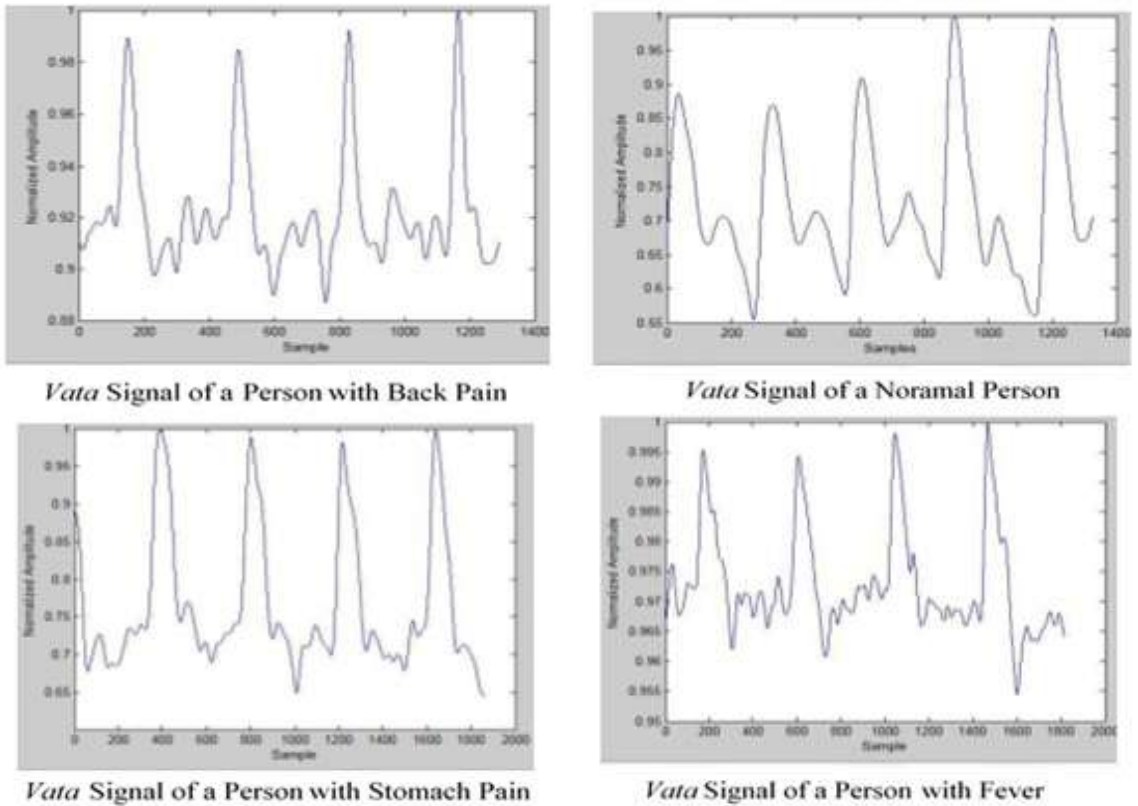
One such design is Nadi Tharangini, which consists of three flexible diaphragms element provided with strain gauge and a high grade industrial transmitter cum

amplifier of output 4-20 mA. 500 Hz sample rate and 16-bit quantizer which convert the output of amplifier to 2-10 V with 500ohms resistor have been used in Nadi Tharangani. However, the data collected from Nadi Tharangani was not much accurate due to electrical and electronic noise. Nevertheless, the developed system with proper shielding reduces the noise level to a negligible value (Joshi et al., 2007).

Ashok Bhat and his fellows developed another Nadi Tharangani system which holds the patent number US 20100152594 A1. This system captures small pressure units accurately and reproducibly with negligible noise. During their research, six pulse waveforms are acquired from the same subject, three from each hand. Exact values are captured by introducing small air gap between the each sensing element and skin and computer algorithms. Pulse data are classified into different types and sub-types. This system is supposed to minimize the human pulse examination errors and provide accurate and quantitative information for diagnostic purposes (Bhat et al., 2008). Nadi Yantra composed with three identical piezo based sensors, amplifiers, data acquisition subsystem and filtering circuitry, is another objective approach towards the pulse diagnosis. Positions of the three fingers like protrusions are adjusted at the tip as required to figure out best points for signal capturing. Springs are attached to protrusions to eliminate natural damping (Kumar et al., 2008).

Nadi Parikshan Yantra, a three point radial pulse examination system consists with three identical data acquisition channels which is used to capture pressure data at vata, pitta and kapha. Three identical pressure sensors of 10mm diameter arranged on an acrylic module is used to capture the signals simultaneously. Sensors were kept apart approximately 6mm from the adjacent sensor. These three sensors are connected to three identical data acquisition channels by using coaxial cables and three different channels are used to display the acquired signal on the computer screen (Kalange et al., 2012).

Another system for pulse examination was developed using optical pulse sensors, microcontroller ATMEGA328 and LabVIEW software. is used to display the data. 8th order butterworth low-pass filter (180Hz) with a flat frequency response is used for pre-processing. Data was classified into Vata, Pitta and Kapha according to the pulse repetition rate, frequency, amplitude, mean and standard deviation. This system is supposed to help the physicians for Nadi pariksha and prognosis of cardiac related disorders. Furthermore, it can be used as a home



**Figure 4. Different pulse obtained for Vata signal in different health conditions (Bhat et al., 2008).**

based health monitoring system as it is a portable wearable device (N, Shivaram, and Shridhar, 2016).

Prototype system was suggested to capture human wrist pulses using three piezoelectric sensors. NI USB-6210 multifunction data acquisition card and MATLAB were used for data acquisition and processing. This system can be used to detect diabetes either by tridosha analysis or ANN as soft computing tool. The real time PC based system helps to check the prakriti of the subject at any time according to the heart rate variability (Kulkarni, 2016).

One more pulse capturing system was developed using piezoelectric transducer which is an active transducer and had a good dynamic response without a dc shift. Transducer was attached to a small sphygmomanometer cuff. Cut-off frequency and the gain of the filter/ amplifier circuit is 100 Hz and 10 respectively. Power line interference noise

was removed by using a notch filter of 50 Hz. To validate the result of classification of data into Vata, Pitta, Kapha, comparison with standard pulse pattern for Vata, Pitta and Kapha and guidance of Ayurvedic practitioners were taken. Accordingly, conclusion was made as Vata, Pitta and Kapha can be classified by observation of pulse repetition rate of waveforms (Kalange & Gangal, 2007).

An autoregressive (AR) model with the selected reference value was developed for wrist pulse signal time series analysis. The residual error (difference between the actual measurement of the new signal and the by reference signal) was calculated and considered as the disease sensitive feature. Wrist pulse signals were acquired using a Doppler ultrasound device. The analyzed results showed the accuracy over 82% in distinguishing healthy persons from patients with acute appendicitis and more than over 90% for other diseases. Thus, the conclusion was made as wrist pulse analysis can be used to indicate patients



of specific diseases among healthy subjects (Chen et al., 2011).

After conducting a case study, Alakananda Devi states that Ayurvedic pulse based diagnosis is capable of doing non-invasive diagnosis which gives similar results to new techniques such as biopsy or CAT scan. Moreover, early diagnosis of cancers can be done non-invasively without any side effects (Devi, 2013).

## 5.0 Conclusion

Accordingly, the conclusion can be made as non-invasive diagnostic devices might be developed with the help of fusion of Ayurvedic medicine and modern technologies with reduced cost and time for the diagnosis. Moreover, it might become a good approach to protect the declining valuable techniques of Ayurvedic medicine.

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# KF IMPLEMENTED FLYING WING

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**Abstract** - In modern aviation the main emphasis is pointed towards the direction of improving the efficiency of operation. The design of the aircraft is solely concerned on providing the most effective operating conditions. Designing and developing a new aircraft design needs to be encompassed with the best corporation of forces acting upon to bring out the most efficient flight. In any aircraft design the major apprehensions are on the basic coefficients such as lift and drag. Respectively with the combination of forces acting upon will bring out the collective operating perspectives of the aircraft. With the aid of a 3D designing software and with the assistance of manual designing the aircraft is modelled. The comprehensive use of K – epsilon model in a 3D domain with second order upwind discretization have promptly provided the results as satisfying.

The working conditions are to be complied with the general operating conditions of a major airliner used aircraft. The conventional designs are optimized up to a crucial level that have reached the peak with the rising edge of technology. The computational fluid dynamic methods need to be carried out in the rudimentary operating conditions in order to ascertain the condition of the design in the natural constraints.

The analytical data have taken a path toward a considerably profound aspect ratio, though the basic design is optimal in operational conditions. Apart from the upper and lower boundaries of operation envelop, the calculations need to be conducted from an inferior level that can bring out its primary stages of operation and build up towards all the conditions with future simulations. Which can be subjected with further computational power towards more effective simulation data finding.

**Keywords** - Flying wing, Kline Fogelman airfoil, Computational Fluid Dynamic

## I. INTRODUCTION

The concept of flying wing had been in play even before the First World War. William Dunne's flying wing design was given to the world before the world war but was still in the research stage. After 1915 Hugo Junkers' firm was able to build up a better design for the flying wing. The designs made for world war one was able to give a stable and greater leap in flying wing concept.

After the world war the flying wing concept was taken for consideration to be built for commercial airliners. With least drag this concept was an ideal design to carry passengers in a larger number. With time the flying wing concept was kept aside in only for military purposes.

The flying wing concept is kept under research in the modern world such that there are new power sources to increase the efficiency of the concept. The latest accomplished design in flying wing Northrop Grumman Switchblade (2008) as a UAV project done in United States. The KF airfoil is the least sophisticated design that can be manufactured with less effort but after manufacturing can gain greater efficiency in use. As the material usage is less the manufacturing cost is reduced to a minimum. The KF airfoil is designed over a 50 year ago but still is in a developing stage. There are 10 KF designs but only 6 of them have been analyzed and 4 are still under development. As the KF airfoils have the least possibility of stalling as it has the ability to achieve higher angle of attack even greater than 60degrees.

The KF airfoil shapes have the capability of successfully achieve higher or lower speeds in a wide range. These wings have the ability to gain more lift with a heavier pay load and can gain faster speeds with less pay load.

As drag is a crucial factor with the KF design the drag acting on an airfoil is being able to be reduced to a minimum. As most of the shape of the airfoil is maintained by circulation of air the friction also have reduced to a minimum thus giving a greater advantage in acquiring greater speeds with less power.

The design issues that have risen from the flying wing concept have withdrawn more designers from developing the concept far more. The inability of smooth manoeuvring has become a major scale disadvantage in this concept as this is a tailless aircraft. Also, problems occurred when fitting in the pilot cockpit, engines, flight equipment etc.

With the abilities of KF airfoils the path for easier control and building up space for all the essential components without decreasing the efficiency of the aircraft are looked forward in achieving.

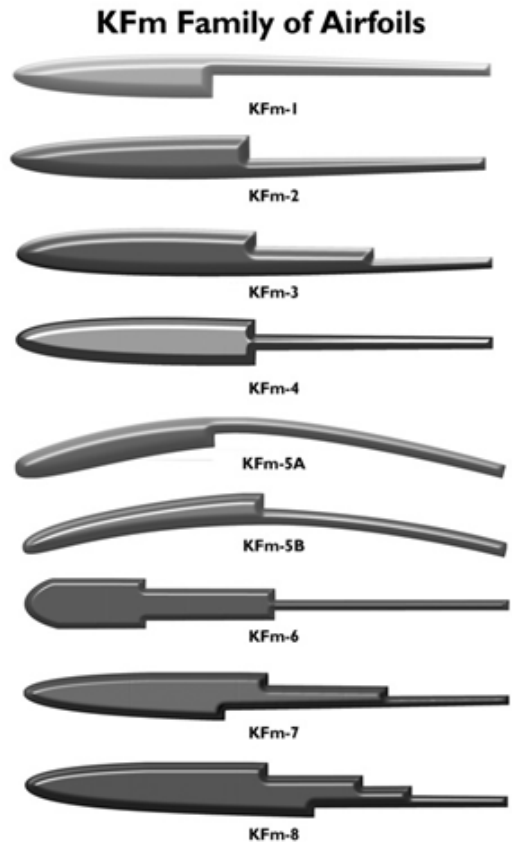
## II. LITERATURE REVIEW

The literature review under the topic of KF implemented flying wing designs as such. Within this research, a new design in flying wing concept is to be proposed in implementing with greater capacities in all aspects. In this literature review it is based on the details which were comprehensively surveyed by other researchers. This review will be done sequentially with literature regarding Kline Fogelman air foils, Flying wing designs and implementation of flying wing concept.

The facts will be taken into consideration in designing the new flying wing design and the proven drawbacks will be considered in mitigating in the new design as well as the advantages to be improved.

In accordance with the reviewed research papers, the analytical facts were given as follows.

### A. Kline-Fogleman (KF) Airfoils



**Figure1. KF Airfoil family**

According to Kline (2009) there are several advantages of using a KF airfoil over a conventional airfoil. As the prime condition that any aircraft design is looked forward in achieving is the reduction of weight and increment of strength and efficiency the KF airfoil have the ability to achieve those conditions in an effective and economical manner. As mentioned by Kline the reduction of drag had been a major outburst in KF airfoils. As the air passes over the airfoil part of the air itself acting as the surface of the foil had given the largest perk in using KF airfoils over conventional airfoil. According to the study the number of advantages given by the KF airfoil have increased with the change of shape. As the KF airfoils have the ability of deviating its centre of gravity it the payloads that being carried can be increased accordingly. The stability of this airfoil shape has increased in a higher range compared to the conventional airfoil. The most essential fact of the KF

airfoil according to this study was the elimination of the stabilizers and the rudder as the shape having its own ability of keeping the stability, thus it has created a design with less drag. Having the ability of smooth flying over higher speeds of air flow have given an added advantage for this foil. As the fuel efficiency of the foil have got increased due to reduction of friction have given an economical leap to this design. As the final implementation is about to go on UAVs as per the study indicates the financial expenditure have reduced to a minimum due to the less use of material to accomplish the design of the KF airfoil.

With respect to the literature it has been proven that KF airfoils have the least drawbacks with respect to conventional airfoils. As there were several areas which an airfoil should increase its ability KF airfoil had the ability of keeping all those aspects in a stable range.

Powers (2009) have brought out the study in analysing the KF airfoil in practical conditions. The study had given the CFD analysis of one of the KF airfoil shapes from the KF family designs. With this analysis, the prototype has given the necessary details in order to understand the design philosophies of KF airfoils.

**B. Flying Wing Concept**

As the study of Mialon (2002) emphasises the use of flying wing concept was mainly generated due to the need of increment in passenger capacity. Thus to create the working design it had to overcome the efficiency and environmental constraints.

As per the findings of Patil (2006) the design of flexible flying wing was carried out with a model made as a beam and was taken into consideration with respect to the conventional airfoil shape. The research was carried out through an analytical method with an aero elastic system. The design was given 3 propulsive points such that it will keep up the stability as well as the thrust. With the minimum components, it gave the leap of increasing the payload which was an added advantage. With the concentrated payload pods it was focused on keeping the mass distribution even after the mass differ with the payload on. The study was given the design concept on acquiring a better efficiency in use of power.

Fleming (1940) designed a model of flying wing aircraft with greater stability in take-off and landing. Also, this was focused on increasing the load capacity of the aircraft design. In this design, it was based on conventional airfoil

design and was faced along high speeds with minimum resistance. The design was kept with minimum internal components. The design given by Grow (1986) was more concerned in keeping the stability and increasing the angle of attack variations. This was achieved by trimming the trailing edge of the design. In order to gain the stability an upper and also a lower control component was added. Though the components were kept conventional the design aspects were moderated to keep the original objectives to be met.

With another leap of moderated aircraft actions Chen (2005) had given the design the ability of vertical and/or short take-off and landing with a fan propulsion system. The main propulsions used in this design used the vertical thrust generation and the forward thrust generation in cruise.

Due to the limitations with the tube and wing aircrafts being fenced with size factor as the Antonov 225 being the largest and skipping the edge of size was proven to be harder. Such that with this research it promoted a flying wing method in order to overcome the weight factor.



**Figure2. Northrop YB-49 flying wing**

With the above literature, it had become open for research, a more efficient method of overcoming the errors of flying wing concept is in need. Also with these references it had been proven that though the conventional airfoil was suitable for the flying wing concept it was practically proven to be ineffective in some conditions and with that the conventional design have become not the ideal airfoil shape in designing the flying wing concept. Alterations needed to be done in order to overcome all the errors and issues which raised with the above literature. And in order to go past these modern concepts should be taken into consideration and should be put into analysis parallel with conventional design philosophy issues.

In this design, the above data referred from the literature will be critically analysed and will be presented with the use of a design carrying modern concepts which have the ability to overcome those issues mentioned in the literature and will be given systematic solutions for each issue delivered.

## II. METHODOLOGY

An improved model of the flying wing concept will be designed with all the key aspects which are required in developing a proper airworthy aircraft.

The concept of flying wing will be considered due to its unique properties and characteristics. This design will be propagated such that it exercises the basic aspects at the same time avoiding the conventional issues.

The family of KF airfoils will be taken into account as per giving a base for the design to be developed. The specific characteristics which are only provided by KF type airfoils are a major advantage in designing with the least drawbacks.

The design will be made whilst interpreting solutions for the prevailing issues in the flying wing design concepts. There will be proposed modifications for the design to improve the available advantages.

## III. FACTORS TO CONSIDER IN FLYING WING CONCEPT

In developing a design that can overcome all constraints there are several factors to consider in basic design aspects. The basic factors are,

### A. Weight and Balance

- CofG
- Design symmetry
- Longitudinal Stability (zero static margin)

### B. Aerodynamic profile

- Airfoil shape
- Aerodynamic forces
- Air flow profile
- Naturally Trimmed aircraft (Without tail)
- Maximum thickness of airfoil
- Increase maximum L/D ratio

### C. Environment and Operation conditions

- Operating Speed
- Operating altitudes
- Environmental factors

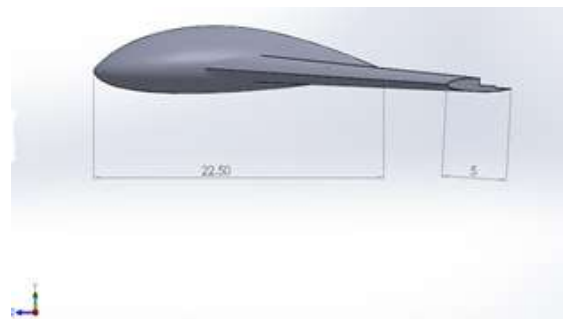
The developed design will be able to exercise the above factors with maximum caution and specific characteristics.

## IV. BUILDING DESIGN

The design which developed is with the aid of the Northrop YB-49 flying wing as well as the Northrop Grumman B2 Bomber. These two aircrafts being the only flying wing designs that are used in NON-CAT operation the design which will be developed need to be operational in any condition. This need to comply with any commercial situation. As the design is considered to be operated in high safety concerned conditions the parameters need to be taken from an aircraft which is already working under the perfect airworthy conditions. With the aid of the prevailing blended wing designs the primary flying wing will be designed and put into simulation to present the forces and coefficients acted upon contained with the flow patterns. The combination of flying wing concept and the KF airfoil design build the theoretical assumption of better lift to drag ratio. With this design it is looked forward in developing the design to have the optimal L/D ratio that is achievable.

## IV. PROPOSED DESIGN

Given below is the developed design in the concept of flying wing with combination of Kline Fogleman airfoil concept. This design is provoked with only the basic design put towards identifying the aerodynamic parameters by simulations.



**Figure3. End elevation**

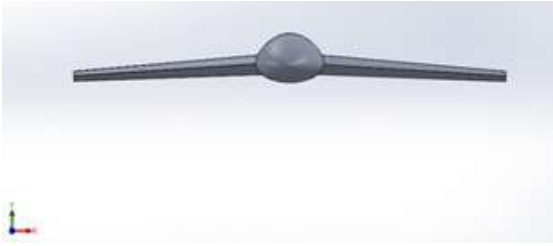


Figure4. Front elevation

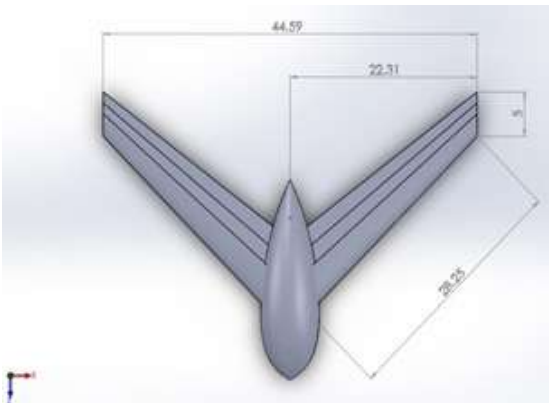


Figure5. Plan

This airfoil shape is inspired by the KF3 generation airfoils. As mentioned previously the steps are propagated from the coordinates of 50% and 75% of the Chord length. The main reason being the reduction of weight and drag. With this concept as the design is hollower less material weight is involved. As for the drag reduction, the vortex cell generated near the steps will reduce the drag by theory. With this the stepped part will not directly produce friction because it is air against air.

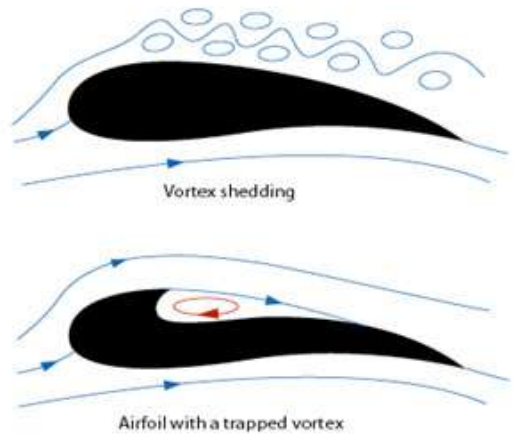


Figure7. Air vortex cell

(All dimensions are in meters)

The AoA is kept at 30 provided that it can improve the coefficients. Above provided design is the basic design keeping all key factors in developing the flow simulations in order to achieve a model with optimum aerodynamic capabilities and beyond.

**A. Aerodynamic Profile**

**1) Airfoil Shape:**

As it's mentioned above the airfoil shape used in this design is extraordinary than the conventional airfoil shapes. There are several reasons in using this airfoil shape.

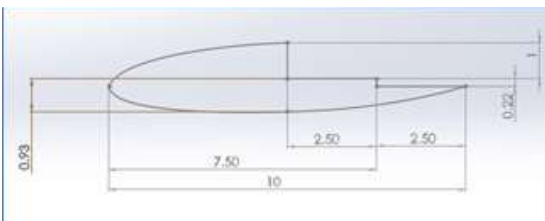


Figure6. Airfoil Shape

**2) Mean Aerodynamic Chord (MAC):**

The mean aerodynamic chord of the designed aircraft is calculated with the geometrical design theory using Solidworks.

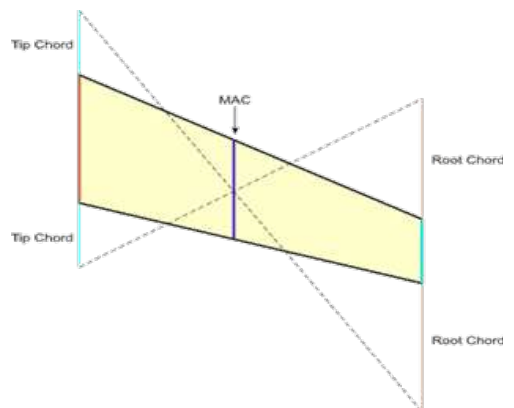
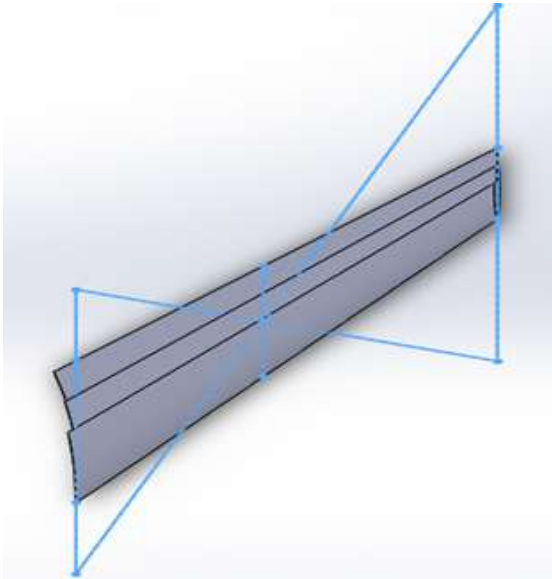


Figure8. Geometrical method

With the use of this method the design is modified in order to find the MAC.



**Figure9. Modified design**

RC=Root Chord

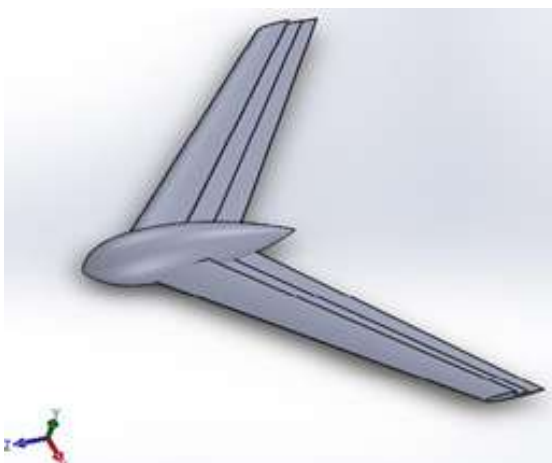
$t = \text{Taper Ratio} = (\text{Tip Chord} \div \text{Root Chord})$

$\text{MAC} = \text{RC} \times \frac{2}{3} \times \frac{(1 + t + t^2)}{(1 + t)}$

With this modification, the MAC is measured to be 7.777 m.

This value is used as the reference length in the simulations as well as the Chord length throughout the simulation process

**B. Naturally Trimmed Aircraft (Without Tail)**



**Figure10. Flying wing Design**

The design is built with the concept of tailless aircraft pre-known as the flying wing.

**IV. FLOW SIMULATIONS OVER THE AIRCRAFT DESIGN**

With the aid of the computational fluid dynamics (CFD) softwares ‘OpenFoam’ and ‘Ansys Fluent’ the simulations were used to identify the flow patterns of the basic design. In order to achieve these data several hypotheses were taken into consideration and standard operational conditions were given in accordance with general aircraft nature similarities.

**A. Hypothesis and Operating conditions**

In order to run the simulations through OpenFoam and Fluent the following hypothesis have been taken into account with the aid of operational conditions in general aircrafts.

- The flow considered to be Compressible.
- The flow considered to be Turbulent.
- The flow considered to be Newtonian.
- The gravitational effects are neglected.
- Sea level conditions are considered.
- Non-static components of aircraft are neglected (Propeller, Landing gear, etc.).

The above stated assumptions are made through all the simulations.

The operating conditions are decided with the aid of Airbus A320 flying conditions as it is the most commonly used aircraft in the aviation world. As per the A320 operation the cruising altitude stands at 39,000 ft. Thus, in this simulation the parameters selected to build the premise in both upper and lower limits.

The basic operating conditions and aerodynamic parameters that are considered in the simulations are,

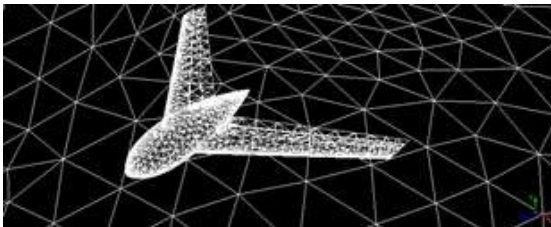
**Table 1. Operating Conditions**

Altitude	Sea level	39,000 ft.
Temperature	300 K	216.65 K
Pressure	101325 Pa	19672.46 Pa
Density	1.225 kg/m <sup>3</sup>	0.3175249 kg/m <sup>3</sup>
Viscosity	1.7894e-05 kg/m-s	1.4220437e-05 kg/m-s
Specific Heat (Cp)	1006.43 j/kg-K	1003 j/kg-K

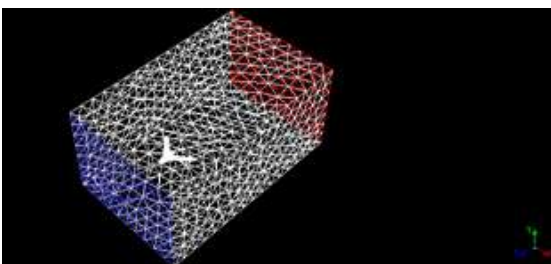
The operating speed is kept as at 240 m/s (Mach = 0.7059) as per the A320 operations.

**B. Meshing and applying boundary conditions**

The meshing is done with the aid of Ansys Workbench and provided with the optimal resolutions such that the smoothest output values can be calculated. The basic drawback in improving the mesh is the computational power of the processors are being limited to a certain level.



**Figure11. Meshed aircraft**



**Figure12. Mesh with domain**

**C. Fluent Simulation Background**

The mesh which is generated with the help of Ansys workbench is exported to fluent as a ‘.msh’ file. The solver used is a pressure based solver with a velocity selected as a condition for numerical solution process in a 3-D domain. The K – epsilon model with realizable and with

Non-Equilibrium Wall Functions. A coupled scheme was selected with second order upwind discretization method and courant number is kept at 50 with relaxation factor of 0.25 (Momentum and Pressure). As the prime objectives were to calculate the aerodynamic force coefficients monitors were activated for CD and CL with a hybrid initialization.

The K – epsilon model is a two equation model which is commonly used for mean flow characteristics for turbulent flow conditions.

**V. RESULTS**

**A. CFD Simulation Data**

The simulations are carried out with the above given conditions and results were collected accordingly. According to Table 2 the values which are calculated are accurate with respect to general aircrafts in use.

**Table 2. Calculated Data from Simulations**

	C <sub>D</sub>	C <sub>L</sub>
Sea Level	0.18722	0.45608
39,000 ft.	0.17399	0.41221

As the design being a newly modelled aircraft the theoretical calculations are harder to achieve with the lack of data regarding the required parameters, this includes critical components such as,

- Material density
- MTOW of Green Aircraft

After considering the above factors the theoretical data can be calculated as well. In the meantime, the process of wind tunnel testing with a scaled down model with exact design should be carried out to check the changing factors of some parameters such as,

- Turbulent Intensity
- Turbulent Length Scale
- Turbulent Viscosity

With the collected data, the basic design can be improved as well.



## VI. DISCUSSION

The designing of the flying wing is carried out primarily with manual drawing of basic components and with the complete design of 3D modelling with the aid of Solidworks software.

As the non-static components are neglected the basic shape of the aircraft is provided for the simulations. As mentioned above the workbench is used for meshing. OpenFoam can be used as a meshing software as well in this scenario. With the aid of the CFD software 'Fluent' the simulation process is carried out. At this stage, there were many drawbacks due to lack of computational power and processing speed of the available computers. As a requirement, this could have been compensated by a workstation with greater processing capacity. This will be recommended as future simulation work.

In fluent the convergence need to be selected and proven correct. In order to give the output with the minimum error percentage the number of iterations need to be increased to a considerable value. Accordingly, to achieve this the number of iterations were increased up to 10,000. In any designed aircraft, the conditions need to be calculated in both sea level and in a range of operating altitudes. With the time limitations and resource limitations the operation conditions of sea level and 39,000 ft. cruising altitude was selected as the primary scope.

Due to computational incompetency, the stability analysis will require further secondary steps towards the future simulations.

The analytical areas of AoA with Drag and Lift domain variation will be able to be delivered with each computation, provided with further resources.

## V. CONCLUSION

### A. Comparison with A320

With the theoretical calculations for the airbus A320,

$$\begin{aligned} C_L &= 2mg / \rho V^2 S \\ m &= 50000 \text{ kg} & g &= 9.81 \text{ m/s}^2 \\ V &= 240 \text{ m/s} & S &= 122.6 \text{ m}^2 \\ \rho &= 1.225 \text{ kg/m}^3 \end{aligned}$$

With the theoretical calculation the lift coefficient value calculated to be  $C_L = 0.1134$  thus with the simulation data the designed aircraft brings out better lift coefficient.

According to the findings and data collected from simulations the flying wing design proven to be an effective in both sea level and high altitude conditions. A considerably higher CL value was presented and the CD value being relatively low builds up the argument of the aircraft model being compiled with a greater Lift to Drag ratio.

With the data collected the design is proven to be aerodynamically stable and in steady condition to be an optimal design of its kind.

The concept of flying wing is considered to be having a greater range when compared with other conventional concept aircrafts. With the combination of KF airfoils the complexity of the design has been improved and the lift to drag ratio is improved as well.

The original objectives of the research have been met up to an exceptional level. With further simulations, the aircraft can be optimized to turn into a better design.

These coefficients are calculated for the whole aircraft.

## VI. FUTURE WORK

- Follow through the 'Openfoam' simulations as well to improve the effectiveness of calculated data.
- Carryout further simulations for changing of AOA, altitude, gravitational effects, etc.
- Workout a wind tunnel practical with a scaled down model to provide more accurate values of force coefficients.
- Improve the design to build up the blended effect.
- Provide more stability to improve the tail down manoeuvring and carryout stability analysis.
- Design changes and simulations with non-static component involvement.
- Modify the smoothness of the aircraft controlling.

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# AN OUTDOOR SMART ROBOTIC GARBAGE BIN TO ASSIST A METHODOICAL GARBAGE COLLECTION, STORAGE AND DISPOSAL PROCESS.

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**Abstract** - Garbage is identified as any matter that is no longer wanted or needed, which is disposed out for no further use of it. Municipal councils face various problems caused due to these tons of garbage that are piling up every month. Garbage piling up may cause bad effects to people as a whole and drifts away the natural beauty of Sri Lanka. During this research, it was identified that these problems has risen due to no proper implementation of a systematic and a methodical garbage collection process. Therefore, in this research the focus lies in the boundaries of proposing a Smart robotic garbage bin which will help to overcome these issues.

The smart robotic bin is proposed with the features of odour controlling, bin space managing, human machine interaction, and Internet of Things (Proposed). The bin is also designed such that it automatically disposes its garbage once the garbage truck has arrived. Its fully enclosed sealed structure prevents unpleasant odour releasing and prevent any uncomforted living in the city. The GPS tracking system enables the position tracking more quickly.

The garbage level indicator, indicates the garbage collectors what bins are to be given more priority. The proposed web server enables the officers to monitor remotely the status of the bin. The compressor mechanism allows the smart bin to store a higher volume of garbage than an ordinary bin. A verification signal is sent via Bluetooth communication from the bin to the truck driver once the disposing has taken place successfully.

This smart robotic bin is an ideal solution to minimize the problems and health issues related to garbage that are faced by countries.

**Keywords** - Smart, Odor controlling, Compressor mechanism, Internet of things

## I. INTRODUCTION

Many nations has identified garbage collection is one of the most arduous tasks that has to be done with minimum disturbance to the people. Currently the garbage process in Sri Lanka happens manually with a team of 4-5 members, where they come in a truck and collect the garbage by pushing off the matter in the bin into their truck bed and then leaving off the empty bin. Due to this, the process of garbage collection happens very slowly and inefficiently which makes households to store garbage in front of their homes and streets.

On the rare days, the garbage is being collected and no prior warning is given to the households, by the time the households come to dispose their garbage, the garbage truck has gone. Since the garbage collectors work as a team, in the absence of a member causes a reluctance among other workers to work as there is a higher workload to be done than before.

Due to these reasons, the garbage starts accumulating. It has been identified that he total waste generation is estimated as 6400 tons/day whereas waste collection is only about 3740 tons/day, which is about 41.56% is not collected. Figure 1 shows the percentage of garbage collected per day in provincial wise.

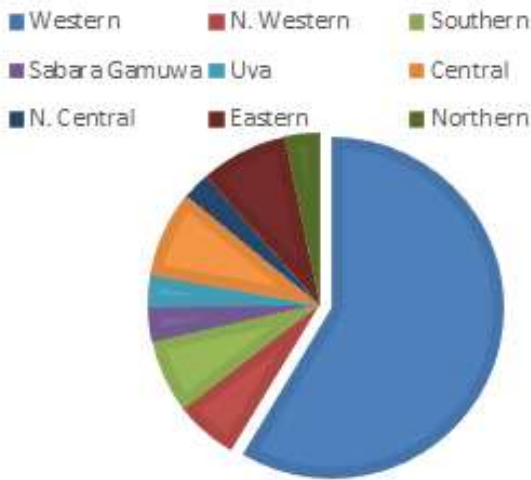


Figure 1. Provincial % of waste collected per day

## II. LITERATURE REVIEW

The development of robotics and smart systems has evolved into many applications in the modern world. To minimize the human interaction and to obtain accurate and precise work lies as the prime objectives in these new systems. There are few robotic garbage bins that has been developed and research has been done on trying to minimize the problems cause by garbage.

“Garbage Collection Robot on the Beach using Wireless Communications” (Sirichai Watanasophon and Sarinee Outrakul) was a Bluetooth control robot which was mainly designed to collect litter on the coastal areas. The caterpillar wheels aid the robot movement on sandy harsh surfaces. The robot had an IP camera mounted on it to identify the garbage. Its basic dimensions were 52x74x17 cm and it was controlled by an application installed onto a smart phone via Bluetooth.

“DustCart, a Mobile Robot for Urban Environments” (Gabriele Ferri, Alessio Mondini, Alessandro Manzi et al.): DustCart is a door-to-door garbage collection robot. The robot will be programmed manually for the household location and the household puts in the garbage and interacts with the robot using an HMI. The robot also has an inbuilt Air Monitoring Module (AMM) which enables

it to monitor the proportion of atmospheric pollutants on air. The Ambient Intelligence Platform (AmI) supports the robot operation through a wireless connection.

“ROAR: Robot based Autonomous Refuse Handling” was a project assisted by Volvo group together with 35 undergraduates from 3 universities. The system consists of a mobile robot which is places at a truck rear. A quadcopter is sent on air to locate the bin position. The robot constructs its trajectory to the bin position. Sonar sensors and odometry sensors aid the robot to go towards its target bin. A gripper is used to grab the garbage bin and come toward the truck.

From the existing work done, it was identified that there is no focus towards a methodical collection of garbage and most importantly to store garbage in order minimizing the effect to the people and environment. The garbage storage was also limited in the existing/proposed systems.

## III. METHODOLOGY/ EXPERIMENTAL DESIGN

The design of the system can be divided into two sub components as the moving bin and the external enclosure.

### Design of the moving bin

The moving bin has two sections as the garbage holding container and the base structure. The automated line follower system is located in the base section while the purpose of the bin is solely to hold and store the garbage.



Figure 2 shows the modelled design for the moving bin.

### 1) Design of the base structure:

The load applied on the moving bin during compression has to be regulated to ensure the structural integrity of the moving bin. This load acts on the garbage container base and on the wheels simultaneously. The manufacturer specifications indicated that the wheels were capable of handling the maximum load to be applied (100kg during compression). The garbage container and the base were the only components which needed analysis to ensure the maximum possible load conditions. As the initial stage of the design, focus was mainly centred upon the base of the bin. The stresses and bending moments acting on the bin during compression (situation when the maximum load is applied) were analysed using ETABS® software which was known to be capable of handling most structural simulations consisting of steel structures. The base was modelled to scale, and a dead load of 100kg was applied as the first stage of the analysis.

### 2) Design of the garbage container:

Based on practical measurements and considering the average density of garbage it was identified that the bin could hold a weight of about 43Kg. A steel structure with an Aluminium skin is proposed to ensure the strength as well as resistance to corrosion. The pressure builds up during the compression stroke should be held by the container without any failure. No simulations or calculation of the exact dimensions of the structural members and the thickness of the skin have been done at this stage. A system to allow a certain pressure leakage during compression is being designed, to decrease the stress applied on the container.

### 3) The line follower system:

The mobile robot follows a black line on the pavement in which the line guides the robot to its targeted position. The line width should be less than the width of the IR sensor panel placed at the bottom of the moving bin. A proposed line arrangement is shown in Figure 3 (not to scale).

### 4) IR Sensor:

Two IR sensor panels are mounted at the front and rear bottom side of the robot. The sensor consists of an IR emitter and an IR receiver, the amount of IR received varies with the black surface which sends the feedback signal to the micro-controller that it follows the line correctly. Once the robot comes closer to the black box (Disposal point)

the outer most IR sensors in the panel will detect it and the robot stops.

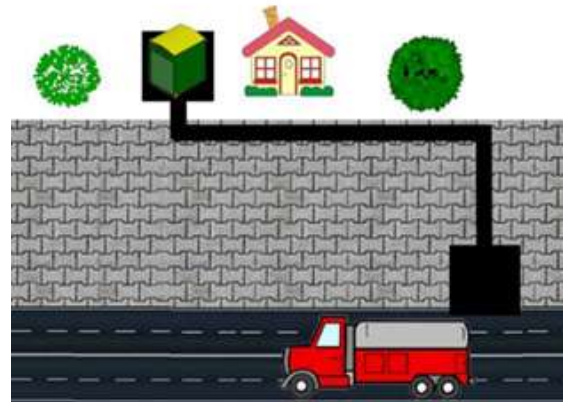


Figure 3: The proposed line arrangement (not to scale)

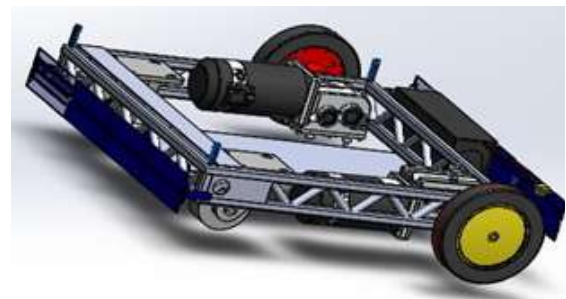


Figure 4: Moving bin base with IR panels are mounted on front and rear

### 5) Charging Mechanism:

The external enclosure and the moving bin has two separate rechargeable batteries. The batteries are charged by the grid supply which is distributed around by the electrical authority. The moving bin consist of a female socket in which the male socket in the external enclosure fuses together thereby charging the battery of the moving bin. Once the bin moves, the pins disengage and the moving bin runs on its charged battery.

### 6) Motors:

The motors of the moving bin require sufficient torque to ensure the bin can accelerate with its full weight. For this, the rolling frictional force coefficient between the wheels and the paved path was considered to be 0.02 for a Dry concrete surface with stock tires.

Required acceleration of the bin,

$$V^2 = U^2 + 2as$$

- V – Final Velocity
- U- Initial Velocity
- a- Acceleration
- s- Displacement

Velocity of the bin was required to be 0.5m/s, and the bin needed to accelerate to the maximum velocity soon after leaving the enclosure and not within it. Hence 's' was taken as twice the length of the enclosure.

Force required to accelerate the bin (F1),  
 $F1 = ma$  (eq.1)

m- Mass

a- Acceleration

Force required to overcome the friction (F2),  
 $F2 = \mu R$  (eq.2)

$\mu$ - Coefficient of Friction

R- Reaction Force

Total force required (F),  
 $F = F1 + F2$

Torque required ( $\tau$ ),

$$\tau = F r$$
 (eq.3)

r – Radius of a wheel

Power (P),

$$P = \tau \omega$$
 (eq.4)

$\omega$  - Based on the velocity requirement of the bin.

The power requirement for a single motor is half of the obtained value as two motors will be used.

**B. Design of the moving bin**

The external enclosure is basically a fixed unit used to contain the garbage. This unit acts as an enclosure to the moving bin and consists of a lid which can be opened to dispose garbage along with the scissor mechanism for compacting garbage, communication system with the server and the charging system for the moving bin. Figure 5 shows the designed 3D model of the enclosure.

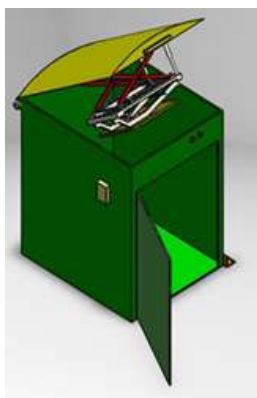


Figure 5: External enclosure

**1) Garbage compression mechanism:**

As a linear actuator would require a considerable amount of vertical space, the compression mechanism was made compact with the use of a scissor mechanism. This mechanism may be powered either by a hydraulic actuator or an electric motor depending on the required torque for that garbage. However, this paper focuses on using an electric motor for this purpose with the aim of simplifying the design criteria of the model.

500 N force through scissor mechanism (Approximately) will be generated. 500 N is experimental value that was obtained by practically compressing the garbage applying different weights on the garbage. Varying the weight and measuring the compression yielded the best compression ratio at a weight of 50kg on the garbage compressing plate acting under gravity. 50 kg weight could compress the garbage by 40%. Therefore, optimum force value of 500 N was adopted. Actuator selection is done to achieve a compaction excessive of 500N in order to compensate for any mechanical losses. Perpendicular distance for force acting is 300 mm.

Torque = force x distance (Position vector)  
 = 500 x 0.3 = 150 Nm

$$p = \frac{\tau \cdot 2\pi \cdot N}{60}$$
 (eq. 5)

$\tau$ = Torque

N= rpm

p= Power

$$\frac{\text{power}}{\text{rpm}} = P : N$$

Stepper with high torque and lower RPM can be used or single-phase AC motor can be used (weight factor of the motor should be considered).

**2) Communication with server:**

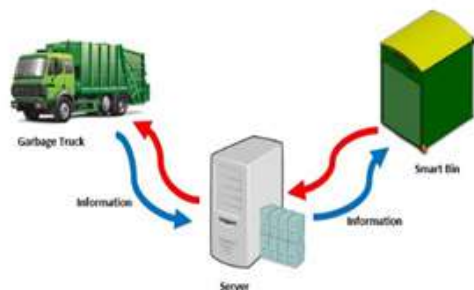


Figure 6: Communication with server

No deep focus is made on the networking area on this research, however the basic networking structure is proposed as in figure 6. A Raspberry Pi micro-controller can be connected to the internet and all communications can be done with the server. A dongle could be connected to a Raspberry Pi to update the server. All communications are done via the server which in turn updates the server system simultaneously.

**3) Lid opening mechanism:**

External enclosure is fully sealed and when the garbage is put only the lid is opening. Lid opening was operated using two electric stepper motors. A Foot pedal was designed to activate the motors.

Approximately decided that whole lid opening had a weight of 10 kg.

Weight included scissor mechanism, motor of the scissor mechanism and lid opening.

Force can be taken as 100 N for calculations and Perpendicular distance for force acting was 600 mm.

$$\begin{aligned} \text{Torque} &= \text{force} \times \text{distance (Position vector)} \\ &= 100 \times 0.6 \\ &= 60 \text{ Nm} \end{aligned}$$

Two motors can be used each has a torque of 30  
From equation 5,

$$\text{Power} = 31.4 \text{ W}$$

Two stepper motors with high torque can be used

**4) External enclosure door opening:**

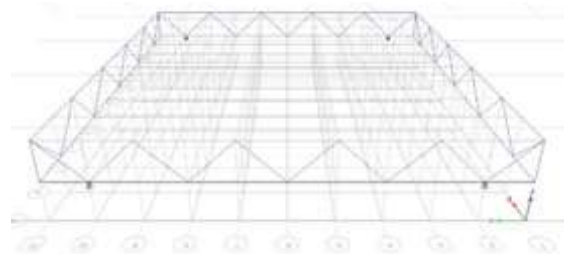
This is done using one stepper motor mounted inside the external enclosure. Once the enclosure receives the signal for the arrival of the truck, this door is opened before signalling the moving bin to activate. After the garbage is collected by the truck, moving bin docks back to initial home position and send a signal to the server. Then the door is closed automatically.

Odour controlling: It is a known fact that baking soda acts as a good deodorizer. A combine mixture of baking soda and cat litter performs more effectively as a deodorizer and as an odour control technique than baking soda alone. The chemical name for baking soda is Sodium Bi-carbonate (NaHCO<sub>3</sub>) which is an amphoteric chemical. Unpleasant

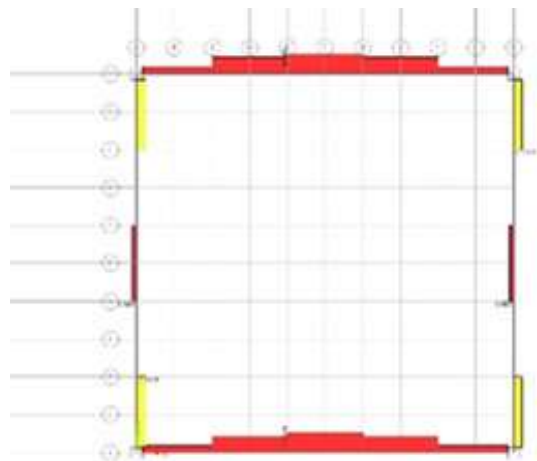
odours are either strongly alkali or strongly acidic, hence NaHCO<sub>3</sub> being an amphoteric chemical neutralizes the acidic or alkali situation of the garbage thereby controlling the odour. A powdered mixture of baking soda and cat litter would be sprayed into the garbage container before each compression stroke.

**III. RESULTS AND DISCUSSION**

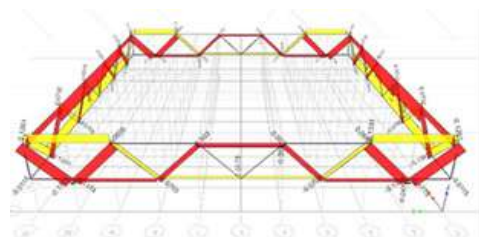
Structural analysis graphical results for the base structure using ETABS® are shown in figures 7 to figure 10.



**Figure 7: Designed structure**



**Figure 8: Axial forces on the base – plan view**



**Figure 9: Axial forces on each member**

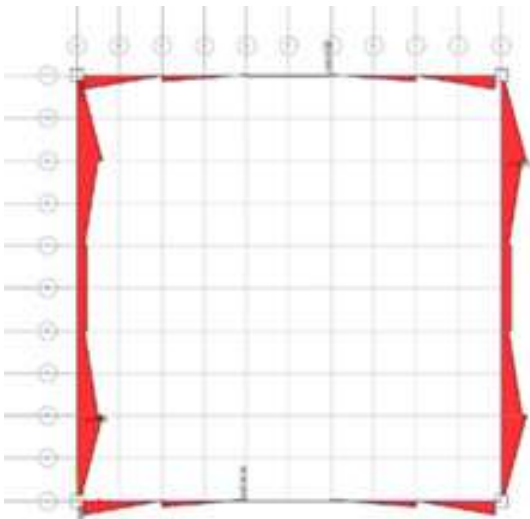


Figure 10: Bending moments on the base – plan view

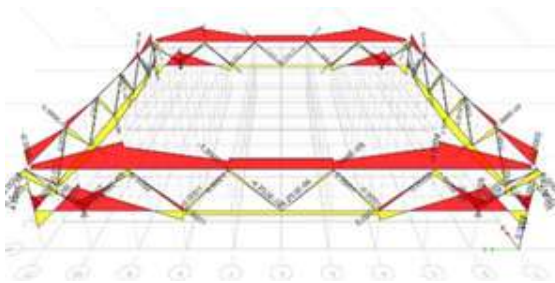


Figure 11: Bending moments on the base

From the above results, the maximum bending moments and axial forces exerted on each member during the compression process with the maximum amount of garbage can be seen. The diameter of each member has been selected to ensure the member can stand 200% of the load exerted during the simulation as a margin of safety. Even though certain members required lesser strength than others, all members were made with equal diameter to ease the fabrication process.

**A) Torque requirement of each motor to be placed to move the base of the moving bin is 7 Nm.**

There would be two motors for moving bin each having torque of 3.5 Nm with power requirement of 1.75 W, with the service factor of 2 (all other losses such as friction and efficiency of the motor are accounted) 3.5W, DC gear

motor could be adopted with maximum torque of 7 Nm and RPM of 10.

**B) Torque required to move the scissor mechanism is 150 Nm.**

P/N ratio of the motor is 15.71.

With the service factor of 1.4, motor P/N value should exceed 24.

Stepper with high torque and lower RPM can be used or single-phase AC motor can be used (weight factor of the motor should be considered)

**C) Torque required to open the lid is 60 Nm.**

Two motors can be used each has a torque of 30 Nm.

P/N ratio of the motor is 3.14.

With the service factor of 2, stepper motors with P/N ratio is higher than 6 can be adopted.

**D)The external enclosure door**

From equation 1:

Force = 100 N

From equation 3:

Torque = 110 Nm

From equation 5:

Power = 4 W

Stepper motor is used which can handle torque more than 110 Nm with 4 W power.

**IV. CONCLUSION**

As this is a conceptual design in which a model or a prototype has not been developed, few expected outcomes will be discussed. Enclosure and the compacting mechanism is expected to have a higher volume of storage more than an ordinary garbage bin. The base design has been proposed to withstand the forces during compressing mechanism. Particularly, the sealed enclosure and the lid with spraying mechanism of the cat litter is expected to prevent related health issues which are caused due to handling or exposure to garbage. These methods can lead to a reduction of the costs, which governments spend on people infected with diseases related to the garbage. Furthermore, the design of this garbage disposal unit has been done in such a way it can maintain the qualitative and quantitative factors than the current methods of garbage disposing and collecting. Line following method is expected to reduce the issues that are caused by garbage



collectors. Communicating through the bins in the area is expected to lead to an improvement in garbage collection. Mostly stored garbage type can be analyzed and schedule the collection process according to the locations. The speed has been match to a slightly lower speed than a walking human being however at this stage the walking speed of a human couldn't be overcome by the moving bin considering its design aspects.

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# DEVELOPMENT OF A PRODUCTIVE WORK CELL THROUGH INTEGRATION OF WORK STUDY AND LEAN TOOLS - A CASE STUDY ON A LEADING TYRE MANUFACTURER IN SRI LANKA.

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**Abstract** - Globalization has paved the path to a rapid growth of world economy while increasing both market competitions of scarce resources. Thus, this has raised a paradox for the businesses to consume resources more efficiently and effectively to seize the competitive advantage with a productive growth. Work-study techniques provide tangible solutions while enhancing the efficiency and effectiveness in both service and manufacturing sectors. Accordingly, lean tools provide the foundation to confirm and endure the productivity concepts.

Therefore, this paper provides an in-depth description of a case study in improving the level of productivity and effectiveness while developing a flexible work cell in a leading Tire Company in Sri Lanka. In the content of this study, a grey tire manufacturing process has been analysed in terms of work measurement to develop a flexible work cell through workload balancing and lean tools like 5S, Root cause analysis etc. Correspondingly, the contribution of this study has enabled the Final preparation cell of the Grey tires to increase the cell productivity from a level of 43.75 units/mhr to 70units/mhr. In conclusion, the results of this study confirmed, that work-study and lean tools could work collaboratively to produce a highly productive and efficient system in a Sri Lankan manufacturing entity.

**Keywords** - Work-study, Lean Tools, Productivity, work load balancing

## I. INTRODUCTION

In a highly competitive global market, it is essential to enhance productivity to increase gross profit and seize competitive advantage, of any business regardless of their scale or the type of industry. Thus, a productive manufacturing system is a result of a combined system of efficient human resource, machines and effective processes that produce high quality products that grasps total customer satisfaction. Therefore, to improve productivity it is necessary to drive our focus on all those areas simultaneously. The definition of “productivity” has been explained by Durana et al. (2015) as a tool to measure the extent of output that can be reaped out of a given input. Accordingly, it could put into an equation as follows;

$$\text{Productivity} = \frac{\text{(Out Put)}}{\text{Input}}$$

Improving productivity is diverged from increasing production, as productivity implies the ratio of effective output over the inputs. Therefore, the focus on both efficiency and quality or the effectiveness are crucial factors when improving productivity of a process (Kulkarni et al., 2014). Hence, productivity improvement has become one of the most significant strategies to achieve excellence in operational performance while enhancing customer satisfaction through attempting to reduce all forms of wastes (Zhang and Chen, 2016).

In literature it has been emphasized that adopting to methodologies such as Lean Manufacturing (LM) with effective use of available resources while reducing wastes, have successfully accelerated the productivity of manufacturing entities (Mahmood and Shevtshenko, 2015, Gupta and Jain, 2013, Kulkarni et al., 2014). Most significant insight behind Lean Manufacturing is to develop a culture that embrace the competitiveness by generating solutions to reduce waste while adding value to the final product (Perera, 2016). Specific methods and systems that are used to eliminate or identify wastes in Lean management philosophy are known as Lean Tools (Smally et al., 2011, Abdullah, 2003). Consequently, Lean tools play a vital role in improving and sustaining productivity successfully (Harris et al., 2014).

Work Study is a systematic and scientific methodology that aids in measuring the factors that are strongly related to overall efficiency of a process such as Labour productivity, standard process time and standard work (Peer, 1986, Kulkarni et al., 2014). Literature on productivity improvement in manufacturing sector comprises numerous applications on LM and Work study tools in isolation. But there exist a limited number of studies that focus on the results of the combination of LM and Work-study tools on improving productivity. Thus this paper explores a successful application of Lean tools collaborated with Work-study to enhance the productivity of a work cell in multinational tire company in Sri Lanka.

## II. CASE STUDY

Focus of this case study is to improve productivity of the finishing cell of Non-Marking (NM) tires in a leading tire company. Process flow of the final preparation of the NM tires can be represented as bellow;

The cured tire that comes out of the oven will go through a trimming and flash removing process and then sent to the final preparation cell after stacking in pallets. Once the pallets are being dispatched from the forklift the buffing operator picks them up and buff the flash off. Then the buffed tire will go through a grinding process to remove excess flash on the sides of the tire while smoothing off the surface of the wheel. The grinded tire will next pass into a washing process where the dirt will be washed off. Then, a thick coat of Etch primer will be applied into the grinded area of wheel to prevent oxidization. Finally the tire will be inspected visually for defects and perform other quality

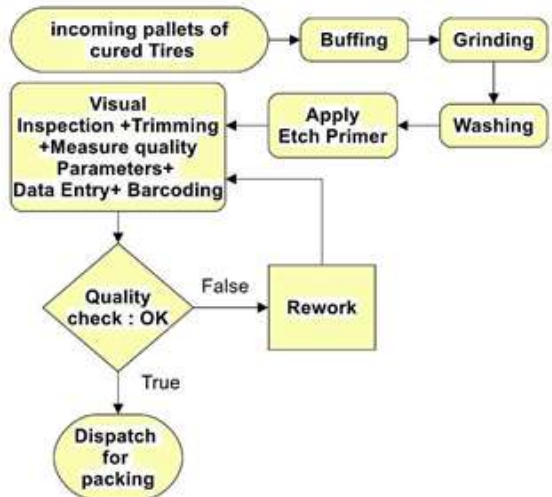


Fig 1. Final Preparation Process

measurements by the Final Quality Checker (FQC) with a final touch of trimming. FQC is responsible for data entering and barcoding as well.

Quality measures at the FQC point include, measuring the Pitch Circle Diameter (PCD) -20%, Eccentricity-10%, Bonding Check- 20% and Centre Bore Key -100% which are non-destructive tests that examines the quality of the Tire. Except FQC works station each work position restrained to a single operator and a helper to load and unload gravity conveyors.

### A. Problem Statement

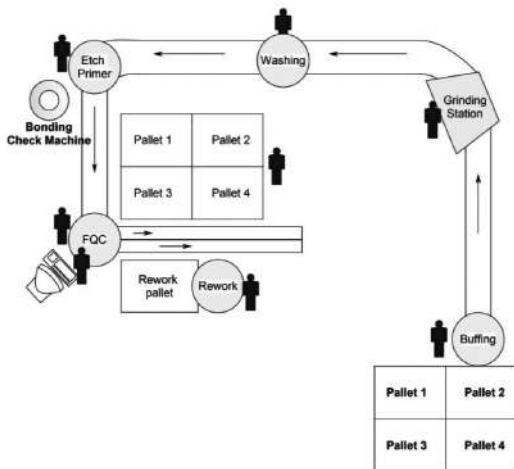
Final QC work station has been identified as the bottleneck of the finishing process as it has been overloaded. By excessive WIP stacked on the floor to go through the FQC process will generate instabilities such as dirt on tire surface while being exposing to dust, which is a threat to the quality of the product and cost additional work to recover.

Therefore, it is essential to measure and balance the workload between other work stations within the cell to achieve predefined productivity level of 60 units/mhr, under a varying Demand of (100- 500) units/Shift. The cell receives the production schedule weekly, but without measuring the system and without a formula to retain the productivity within the cell it is difficult to develop an effective flexible work cell.

**B. Before the improvements.**

**Table 1. Font sizes for this publication**

UNIT	MEASURE
Number of Labour	8
Max. Production	350
Labour Productivity	43.75 Units/ Mhr
WIP	260



**Fig 2. Layout before Improvements**

Fig 2 depicts the allocation of blue collars and the cell arrangement before the implementation of improvements.

**III. METHODOLOGY**

Lean manufacturing provides a unique approach to solve problems. It does not focus on the effects of the problem that lies on the surface rather it eradicates the roots of the problem providing a permanent solution. Therefore, this case study has been cascaded into five major areas.

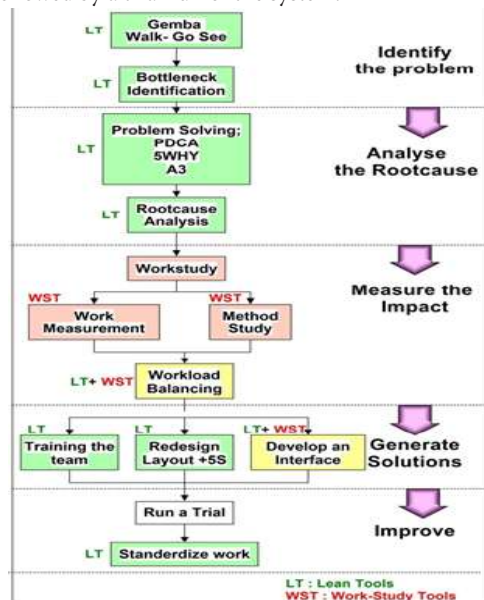
1. Identifying the Problem – According to Shaikh and Kazi (2015) defining the problem is more crucial in to solve any problem. Gemba walk is a tool in LM, which was used to collect lively observations and identify corrective points.

2. Analyse the Root Cause – The objective of this phase is to isolate the root-cause that develops problematic processes (Antony et al., 2012). Tools like PDCA (Plan, DO, Check, Act), A3, 5why and fishbone diagram could be used in this stage. For this case study all these tools were interacted with the thinking of operators who are exposed to the real situation.

3. Measure the Impact – Scientific measure of this case study is the time. With the help of method study the current practices that help to produce work elements. Further the loopholes in current method were examined to generate more efficient and effective methods. With the help of identified work elements, the process time for each work station were measured through work measurement tools considering each size of tire and then performs a workload balancing.

4. Generate Solutions – This process will initiate with a knowledge sharing session on Lean management and the need for improvement. By merging the ideas generated from operators and both managers major transformation of the cell begins with a layout change and 5S implementation. Finally, a simple interface was developed using Visual Basic to calculate and schedule the labour hour to retain the productivity.

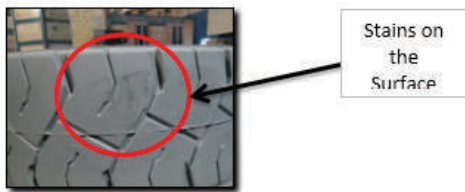
5. Improve Phase – Standardizing the results were done followed by a trial run of the system.



**Fig 3 Methodology**

**A. Gemba Walk**

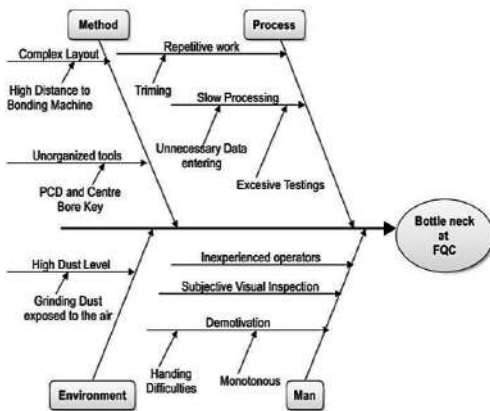
As a result of Gemba walk the team could identify the bottleneck of the work cell visually as the tires were loaded on pallets that are to be process through FQC work station since the WIP rack is not sufficient for the bottleneck. The dirt on the surface of the tire requires rework on buffing before shipping. Therefore, it adds ineffective time to the process.



**Fig 4 Dirt on Tire surface**

**B. Root-cause Analysis**

Factors and their root-causes were examined through the fishbone diagram as shown below.



**Fig 4 Fish Bone Diagram**

**C. Method Study**

The current practices of FQC highlighted man inefficient points such as the data entry form has repetitive sets of data to be entered. Also, since the bore key and PCD tools were not organized it takes additional time to select the tools for the testings. FQC operator had to trim the tire once again to give a finishing touch to the tire which is

a repetitive work. Measuring eccentricity is tedious as it doesn't have a stencil to follow. Moreover, checking the bonding strength includes unnecessary transportation as it is far apart from the FQC point.

**D. Time Study**

A time study of each work station was collected for all three shifts and all sizes of tires. To validate the result of the time, study a sample of 12 units from each size were examined. There are five tire sizes that was focused on taking the time study. A shift may have man different sizes as per the mould changes. Especially in FQC point the testing times will be analysed to examine their process times.

**Table 2. Average Number of tires checked per shift without quality ests at FQC**

Size	Time taken for a unit	Total time (s)	Min/S shift	hr./Shift
12x4.5	86.92	28681.95	478.03	7.97
323x100	93.53	30863.25	514.39	8.57
15x5	95.44	31493.55	524.893	8.75
16x5	72.01	23763.3	396.06	6.60
406x125	101.33	33438.9	557.32	9.23
<b>Average</b>	89.84	29648.19	494.17	8.26

**Table 3. Time taken for quality measures**

Quality measure	Average cycle time (s)	Frequency per shift	Time taken (s)	Min/Shift	hrs./Shift
Eccentricity (10%)	106.2	33	3505	58.4	0.97
Bonding (20%)	125.9	66	8312	138	2.31
Centre bore key (100%)	48.5	330	1601	267	4.45
PCD (20%)	53.5	66	3528	58.8	0.98
Hardness	15.1	350	5285	88.01	1.47
Tire rolling on the rack	17.23	13.75	237	3.95	0.07
Stack in Pallets	84.57	13.75	1161	19.4	0.32
<b>Total time taken for quality parameter check =</b>			<b>32766</b>	<b>546</b>	<b>9.1</b>

**E. Workload Balancing**

With the average time taken for a unit, loaded hours per shift was calculated for each work station including the extra activities and time taken to perform quality tests.

Takt Time: The word ‘Takt’ reflects the meaning of rhythm in German language. Thus, Takt time in a process indicates the rhythm of the process, by considering the available time per unit over a specific demand. Takt time of a process can be calculated using the following equation;

$$\text{Takt Time} = \frac{\text{Available Time}}{\text{Demand}}$$

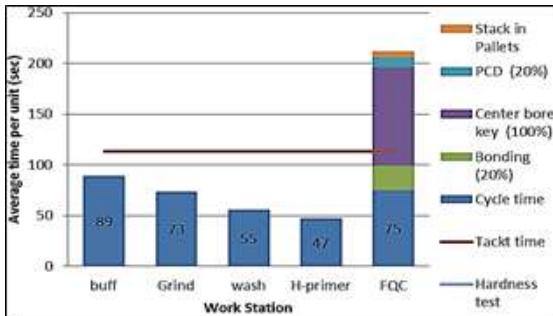


Fig 6 Workload of current process

**III. Results**

Data collection was broken into two stages;

- i. Collection of production Data (Work cycle time & Takt Time) prior to analysis.
- ii. Collection of data of data after implementation of case study suggestions (Work cycle time & Labour requirement)

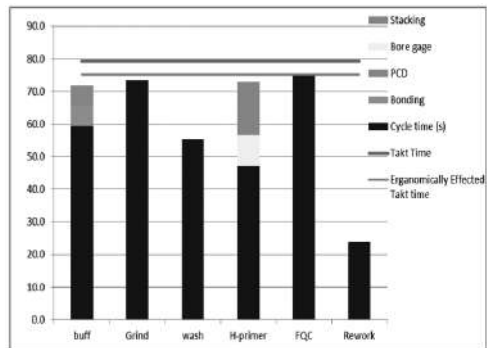
From the ideas generated from root-cause analysis, layout was changed and the excess workload of FQC was distributed among the other work stations. The quality parameter tests were distributed among the other work stations and developed a gravity conveyor system to maintain the flow of the work cell continuously. Amount of WIP have been reduced while adopting the system into one-piece flow. Since each work cell has designed to produce a unique output a need for a comparison of Takt time across work cells is not applicable in the context of this case study.

**Table 4. Overall Improvement**

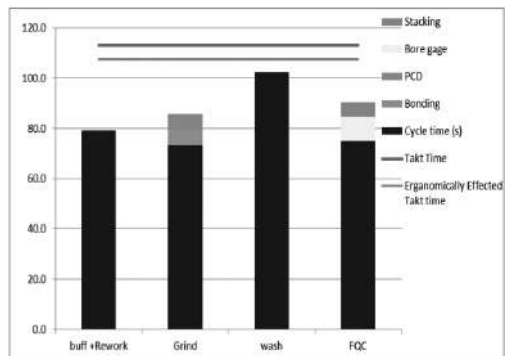
Unit	Measure	Improvement
Number of Labour	5	3
Maximum production	500	Increased by 150 units
Labour Productivity	70 Units/ Mhr	60%
WIP	164 units	96 units

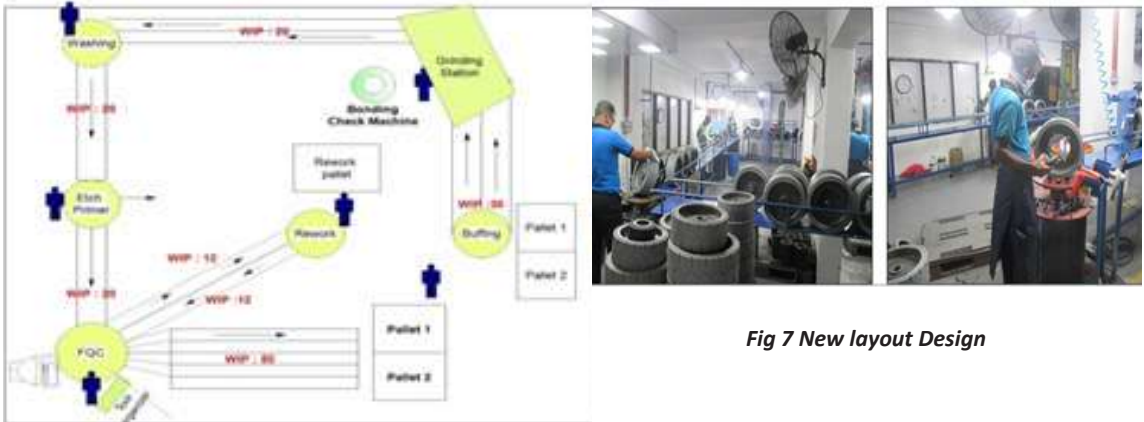
**iii. DISCUSSION & CONCLUSION**

NUMBER OF PIECES = 500  
TAKT TIME = 79.2



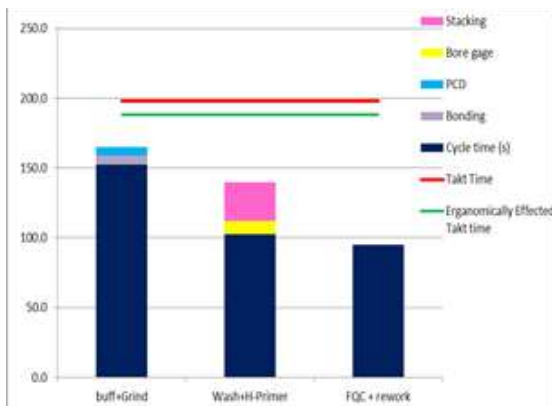
NUMBER OF PIECES = 350  
TAKT TIME = 113.14





**Fig 7 New layout Design**

**NUMBER OF PIECES = 200**  
**TAKT TIME = 198**



**Fig 8 New Workload Distribution**

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# PROBABILISTIC APPROACH TO ASSESSMENT OF DAMAGE SURVIVABILITY OF CARGO SHIPS

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**Abstract** - This paper deals with use of the new SOLAS 2009 probabilistic approach to the assessment of damage survivability of a cargo vessel. Method is used for an existing cargo vessel to assess the level of survivability. Further the influence of height to the center of gravity (or GM) and permeability of cargo spaces are also investigated. The rationality of the approach is demonstrated taking into consideration various possible damage scenarios and their influence on the overall survivability index. The regulation defined the maximum height of the center of gravity to be used as limits given by the intact stability conditions. However in reality KG values of the loaded ship varies significantly and the influence this change to the attained index of subdivision and level of survivability is discussed here.

## I. BACKGROUND

Shortly afterward of the Titanic Disaster in 1912 the need for damage stability regulations and a criteria of assessment have been realized. Subsequently guidelines for subdivision and positioning of watertight transverse bulkheads were developed for passenger ships based on floodable length and factor of subdivision. This approach was known as deterministic method in which survivability is assessed for cases when damage to single compartment, two adjacent compartments etc. depending on length of the ship. In 1973 IMO assembly adopted regulation on subdivision and damage stability of passenger ships based on the probabilistic concepts by resolution A.265(VIII) as an alternative approach. After the Herald of Free Enterprise (Ro-Ro Ferry) disaster in 1987, there had been significant studies and work on flooding and damage survivability of ships. In 1992 a new section to SOLAS Chapter II-1 (part B-1) entered into force as applicable to

cargo ships, including Ro-Ro ships, on the subdivision and damage stability based on the probabilistic approach[1]. Initially regulations were adopted for ships over 100m in length. In this criterion, an index called attained index of subdivision (A) is estimated on the basis of the summation of the product of probability of flooding and probability of survival estimated for all single compartment and group of compartments (group of 2 adjacent, or 3 adjacent etc.) for all possible cases of flooding[3].

$$A = \sum_{i=1}^n p_i s_i$$

Here  $p_i$  represents the probability of flooding of  $i$ th compartment or group of compartments disregarding any horizontal subdivision and  $s_i$  represent probability of survival after flooding to  $i$ th compartment or group of compartments under consideration.

The estimation of factor  $p_i$  is given in the regulation and based on the statistics of past damage cases and  $s_i$  will be estimated from the damage stability calculation using righting lever of the damaged ship.

For the compliance of the regulation the above index A should be greater than Required index of subdivision R which is based on the length of subdivision for cargo ships. Later in 2005 IMO subcommittee decided to combine cargo ship and passenger ship regulations together and presented as harmonized method in SOLAS 2009.

For Cargo ships, the index A has to be calculated for summer load draft (ds), partial loaded draft(dp) and light loaded (dl) conditions and overall A is estimated with



following weightages. Also different permeability values should be used for cargo spaces depending on the loaded draft. In 1992 regulations index was calculated as average of indexes corresponding to summer load and partial load drafts.

$$A = 0.4 A_s + 0.4 A_p + 0.2 A_l$$

The required index of subdivision for cargo ships above 100m in length is given as

$$R = 1 - \frac{128}{L_s + 152}$$

where  $L_s$  is length of subdivision.

For ships not greater than 100m but not less than 80m in length,  $R$  is given by

$$R = 1 - \frac{1}{1 + \frac{L_s}{100} \frac{R_o}{1 - R_o}}$$

where  $R_o$  is the value of  $R$  according to the previous formula.

## II. CASE STUDY

The above regulations are applied for a general cargo vessel built prior to 1992. This was a requirement by the classification society to check that the vessel can attain present probabilistic standards. The vessel has following basic dimensions and capacities.

Length Overall	= 158.87 m
Length between Perpendiculars	= 145.00 m
Breadth	= 22.80 m
Depth	= 13.40 m
Summer load draft (ds)	= 9.94 m
Displacement at ds	= 23890 tonne
Maximum allowable KG	= 9.27 m

### 1. Light Service Condition:

Light service condition is defined as the ballast condition of the vessel with 10% consumables

Displacement	= 10388.3 tonne
Mean draft (dl)	= 4.74 m
Trim (by stern)	= 2.53m
Maximum Allowable KG	= 10.25m

### 2. Partial Loaded Condition:

Partial loaded draft is given by the light draft plus the 60% of the difference between summer loaded draft and light service draft.

Partial Loaded Draft (dp)	= 7.86 m
Displacement at this draft	= 17689.0 tonne
Maximum Allowable KG	= 9.02 m

The center of gravity values given here are the limiting values given in the intact stability booklet of the vessel. However investigations are carried out for different KG values and the sensitivity of KG to the attained index of subdivision is shown below.

The compartments and damage zones definition with compartment boundaries are given in the annex. Total number of watertight spaces are defined in accordance with the subdivision arrangement as 26 and number of single damage zones are taken as 8 as defined in the appendix. A particular single damage zone is selected as the one bounded by two adjacent transverse bulkhead with appropriate bottom tanks.

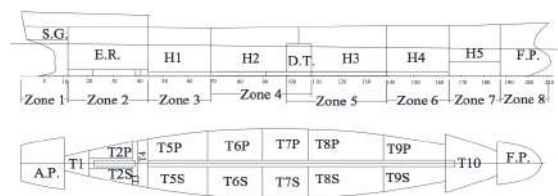


Figure 1. Tanks and Hold Arrangement

When selecting single damage zones both holds below and above tween deck, and relevant tank(s) are considered together assuming damage below tank top does not extends beyond the centerline bulkhead as given in section 3 of appendix. This combination would results in unsymmetrical flooding in the double bottom tanks that may give a worse condition than assuming pure symmetrical flooding.

Any combinations of adjacent zones are considered as summation of such compartments or tanks.

**A. Damage Stability Calculations**

Damage Stability computation is based on the Lost Buoyancy principle considering final equilibrium waterline. The method is being used along with free trim floating condition.

The program performs several iterations until displacement and free trim equilibrium conditions are satisfied for a specified angle of heel. Damage vessel is being inclined to set of predefined angles of heel and then midship draft, trim and location of center of buoyancy are estimated once the displacement and free trim conditions are met.

Righting lever of the damaged vessel is estimated at such predefined angles of heel using the coordinates of the center of buoyancy considering three dimensional inclination of the vessel. Angle of opening immersion and the damage righting lever is very critical for evaluation of the probability of survival and hence use of free trim inclination of the ship is vital in estimating the status of the damaged ship.

The software for damaged stability calculations and use of the regulations is developed by the author some time ago and has been used extensively.

Any complicated damage zone can be input to the programme with set of sub compartment in which their boundaries can be defined. Permeability of each subspaces can be given separately. Appendix shows the results of such calculation for a particular damage case.

**B. Influence of Center of gravity KG**

Above loading conditions show the limiting values of center of gravity according to the intact stability requirement. However attained indexes were calculated for different KG values at the different loading conditions and then results are shown in Fig.2. These indexes were calculated based on the recommended permeability values in the regulations.

It was found that vessel attained low indexes at light load conditions because of the very low statical stability lever of the damaged ship. Attained indexes at partial load conditions are comparatively higher than light loaded conditions.

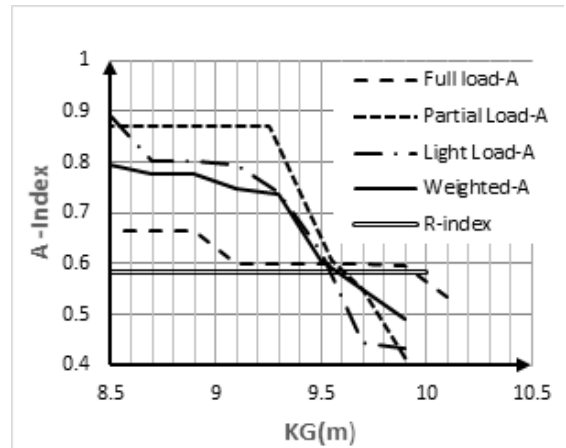


Figure 2. Attained index -A Vs KG(m)

When the center of gravity is above around 9.6m the individual indexes at all loading conditions and the weighted index seems to be falling below the required index. However the above results cannot be generalized as they depend on the vessel and its intact stability conditions. According to the intact stability requirement light loaded KG is 10.25m but at this KG value the attained index is much lower than the required index and hence light loaded KG has to reduce further to satisfy the damage survivability condition.

Fig.3 shows the limiting values of KG according to intact stability and damage stability requirements.

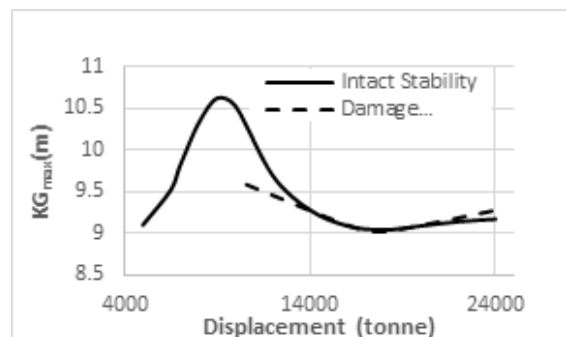


Figure 3. KGmax VS Displacement

Except for the light service condition when damage to any 3 adjacent zones, ship is not surviving. The most critical two adjacent case was the zone 5 + 6. When damage to zone 5+6 ship does not survive for almost all cases studied. Then the next critical case become zone 4+5. As the center

of gravity rises the attained index start dropping due to the fact that probability of surviving  $s=0$  when damage to firstly for 5+6, secondly for 4+5 and thirdly for 3+4 etc. Although the ship does not survive when damage above three 'two adjacent cases' simultaneously the attained index is greater than the required index of subdivision.

**C. Influence of cargo holds permeability**

Permeability values recommended by the SOLAS 2009 is more optimistic than SOLAS 1992 and hence there is not much room to study the sensitivity of the permeability of cargo hold to the attained index. When permeability of cargo spaces is raised to 0.8 at summer loaded condition there was no change in the index A for the same loading condition. Even for partial loaded condition there was no change in attained index A when the permeability is increased to 0.9. In this consideration, KG values are used as the limiting values given by intact stability requirement.

**III. CONCLUSION**

Application of the new regulation needs correct study and clear understanding of how to decide on different damage scenarios. Also particulars like locations of opening position and accurate estimation of righting lever of the damaged vessel are very important because level of survivability completely depend on such factors. Maximum values of the height of center of gravity that can be used during loading has to be re-evaluated for all vessels based on the new damage stability regulations and added to the intact stability booklet. Permeability values recommended by the regulations may reflect the worse condition of flooding for three loading conditions and hence seem to be reasonable compared with 1992

version. Further there is significant improvement in safety standards of SOLAS2009 compared with SOLAS1992 for dry cargo ships.

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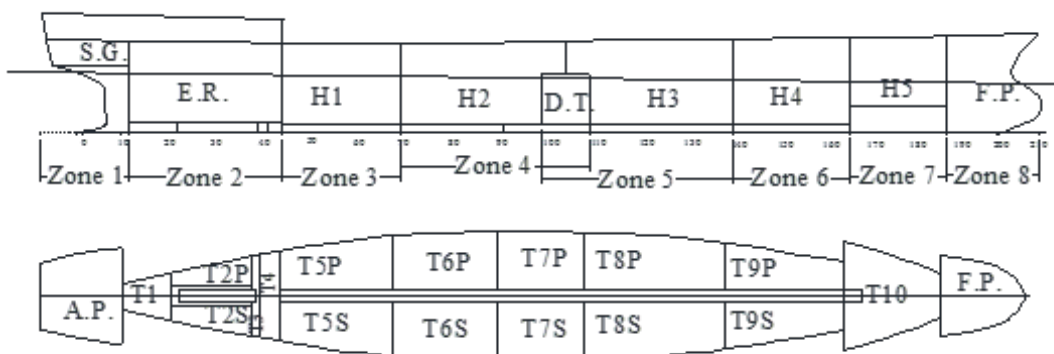
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**Appendix**



**Definition of Damage Zones**

**1.0 Numbering of Tank**

Name	Nomenclature	Location	Distance from Aft. Terminal (m)	
			Aft Blkhd	Fwd Blkhd
Aft Peak	A.P.	Fr(-10)- Fr12	0.00	- 13.2
Steering Gear	S.G.	Fr(-10)- Fr12	0.00	- 13.2
Tank 14	T1	Fr12- Fr22	13.2	- 20.7
Tank 15	T2S	Fr22- Fr39	20.7	- 33.45
Tank 16	T2P	Fr22- Fr39	20.7	- 33.45
Tank 7	T3	Fr39- Fr41	33.45	- 34.95
Tank 6	T4	Fr41- Fr44	34.95	- 37.2
Tank 5SB	T5S	Fr44- Fr69	37.2	- 55.95
Tank5P	T5P	Fr44- Fr69	37.2	- 55.95
Tank 4SB	T6S	Fr69- Fr91	55.95	- 72.45
Tank 4P	T6P	Fr69- Fr91	55.95	- 72.45
Deep Tank	D.T.	Fr99- Fr109	78.45	- 85.95
Tank 3ASB	T7S	Fr91- Fr109	72.45	- 85.95
Tank 3AP	T7P	Fr91- Fr109	72.45	- 85.95
Tank 3SB	T8S	Fr109-Fr139	85.95	- 108.45
Tank 3P	T8P	Fr109-Fr139	85.95	- 108.45
Tank 2SB	T9S	Fr139-Fr165	108.45	- 127.00
Tank 2P	T9P	Fr139-Fr165	108.45	- 127.00
Tank 1	T10	Fr165-Fr187	127.0	- 142.4
Fore Peak	F.P.	Fr187-F.E.	142.4	- 156.0
Engine Room	E.R.	Fr12-Fr44	13.2	- 37.2

**2.0 Numbering of Cargo Holds**

Name	Nomenclature	Location	Distance from Aft. Terminal (m)		
			Aft Blkhd	Fwd Blkhd	Length
Hold 5 + TD 5	H1+ TD5	Fr44- Fr69	37.2	- 55.95	18.75
Hold 4 + TD 4	H2 + TD4	Fr69- Fr104	55.95	- 82.2	26.25
Hold 3 + TD 3	H3 + TD3	Fr104- Fr139	82.2	- 108.45	26.25
Hold 2 + TD 2	H4 + TD2	Fr139- Fr165	108.45	- 127.0	18.55
Hold 1 + TD 1	H5 + TD1	Fr165- Fr187	127.0	- 142.4	15.40

Note : - TD – Tween Deck

**3.0 Damage Compartments Boundaries and Flooding Cases**

The following Zones are defined to consider as *single compartment cases* or floodable space bounded by two adjacent bulkhead. Then the combination of two adjacent and three adjacent are also considered in the same manner as Zone1 +Zone2 , Zone2 + Zone3 etc.

Zone No.	Location	Normalized Blkhd Positions		Length (m)	Included Compartments
		Aft Blkhd	Fwd Blkhd		
1	Fr(-10) - Fr12	0.00	- 0.0846	13.2	A.P.+S.G.
2	Fr12 - Fr44	0.0846	- 0.2384	24.00	T1+ T2S+ T3+ T4 + E.R.
3	Fr44 - Fr69	0.2384	- 0.3586	18.75	T5S+H1+DK
4	Fr69 - Fr104	0.3586	- 0.5269	26.25	T6S+ T7S+D.T.+ H2
5	Fr104 - Fr139	0.5269	- 0.6952	26.25	T7S+T8S+ D.T.+ H3
6	Fr139 - Fr165	0.6952	- 0.8141	18.55	T9S + H4
7	Fr165 - Fr187	0.8141	- 0.9128	15.4	T10 + H5
8	Fr187 - F.E.	0.9128	- 1.000	13.6	F.P

**4.0 Combination of Two adjacent units**

Zone No.	Location	Normalized Blkhd Positions		Length (m)	Included Compartments
		Aft Blkhd	Fwd Blkhd		
1 + 2	Fr-10 - Fr44	0.0000	- 0.2384	37.190	A.P.+S.G.+T1+T2s+T3 +T4+E.R.
2 + 3	Fr12 - Fr69	0.0846	- 0.3586	42.744	T1+T2s+T3 +T4+E.R + T5S+H1 + TD1
3 + 4	Fr44 - Fr104	0.2384	- 0.5269	45.006	T5S+H1+ T6S+ T7S+D.T.+ H2 + TD2
4 + 5	Fr 69 - Fr139	0.3586	- 0.6952	52.510	T6S+ T7S+D.T.+ H2 + T8S.+ H3 + TD3
5 + 6	Fr104 - Fr165	0.5269	- 0.8141	44.803	T7S+T8S+ D.T.+ H3 + T9S + H4+ TD4
6 + 7	Fr139 - Fr187	0.6952	- 0.9128	33.946	T9S + H4 + T10 + H5 +TD5
7 + 8	Fr165 - F.E.	0.8141	- 1.000	29.00	T10 + H5 + F.P.

**5.0 Position of Weathertight and Non-weathertight Openings**

The following table shows that coordinates of weathertight and non-weathertight openings

Opening	Position in meters		
	Long (X)	Transverse (Y)	Vertical (Z)
Superstructure door (non-weathertight)	12.6	3.0	22.23
AH1 (weathertight) – No.1	8.4	7.0	18.0
AH2 (weathertight) - No.2	24.6	11.2	14.0
AH3 (weathertight) – No.3	71.1	11.2	14.0
AH4 (weathertight) – No.4	85.4	11.2	14.0
AH5 (weathertight) – No.5	107.1	5.0	14.0
AH6 (weathertight) – No.6	125.8	11.2	14.0
AH6 (weathertight) – No.7	140.4	0.6	15.2

X- Distance from aft perpendicular, Y- Distance from centerline, Z-Height from baseline

**6.0 Results of Damage Stability Assessment for a Zone 2**

**Loading condition**

Displacement = 23789.8 t Draft = 9.9400 ,KG= 9.300 LCG = 77.904

**Righting lever and damage stability particulars (at the FINAL stage of flooding) when damage to Zone No. 2**

BOUNDARY OF ZONE. X1/L = .085 AND X2/L = .238

SUB-COM NO.& TYPE	AFT BLK	FOR BLK	LLT	ULT	PERM
1 0	.085	.133	.000	1.925	.950
2 3	.133	.214	.000	1.925	.950
3 0	.214	.238	.000	1.925	.950
4 0	.085	.238	1.925	0.000	.850

Ang.heel (deg)	Ang.trim (deg)	Tmid (m)	Vol.Displat (m3)	CBx (m)	CBy (m)	CBz (m)	GZ (m)
.000	-2.148	10.909	23209.57	77.761	-.008	5.797	-.008
2.000	-2.003	10.864	23210.34	77.785	.157	5.804	.035
5.000	-1.878	10.813	23207.78	77.791	.387	5.825	.083
10.000	-1.627	10.664	23208.12	77.805	.806	5.900	.204
15.000	-1.591	10.509	23209.61	77.809	1.230	6.025	.340
20.000	-1.883	10.451	23209.64	77.802	1.595	6.174	.430
25.000	-2.257	10.572	23209.85	77.787	1.856	6.300	.414
30.000	-2.649	10.825	23209.74	77.770	2.055	6.413	.336
35.000	-3.099	11.194	23209.57	77.758	2.222	6.526	.229
40.000	-3.699	11.688	23209.58	77.732	2.368	6.651	.112
45.000	-4.399	12.339	23208.24	77.709	2.491	6.774	-.024
50.000	-5.190	13.154	23209.71	77.687	2.599	6.896	-.171

Angle at deck immersion = 0.000deg  
 Angle at opening immersion = 49.293deg  
 Angle at closed weathertight immersion = 8.921deg at opening No. 2  
 Angle at stability vanishes = 44.105deg  
 Angle of equilibrium = 0.363deg  
 GM\_T at equilibrium = 1.232m  
 GZmax(m) = 0.116 m

# SAFE OPERATION OF TUGS WITHIN CLOSE PROXIMITY TO THE FORWARD AND AFT REGIONS OF SHIPS

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Abstract - When tugs are used for ship assist manoeuvres, hydrodynamic interaction effects between them can adversely affect the safety and handling of the tug. During such manoeuvres, tugs need to frequently change their location and drift angle with respect to the ship in order to provide the required assistance. Such variations can adversely affect the tug's hydrodynamic interaction forces and moments, thus making it vulnerable to collisions or run-overs.

In order to safely and effectively operate tugs in these situations, it is essential that the operators are aware of the adverse interaction effects under different operating conditions and locations, enabling them to take necessary precautions and corrective actions to mitigate the dangers. To date, however, most of the data available in the public domain are limited to an 'ideal' tug assist situation, where the tug is operating parallel to the ship. This study discusses the hydrodynamic interaction effects on tugs operating at drift angles ranging from zero to 90 degrees relative to the ship, when located around the forward and aft regions of the ship and at progressively increasing lateral separation between the vessels. The study was conducted using Computational Fluid Dynamics (CFD) simulation models which were validated against experimental measurements obtained at the Australian Maritime College model test basin.

The non-dimensionalised interaction effects were used to create Hydrodynamic Interaction Region Plots (HIRP) to identify the variation of the coefficients with respect to the tug drift angle and the relative distance between the vessels. The results demonstrate that the safest approach to the ship with the least interaction effects is at a tug drift angle of less than 15 degrees. In addition, once the tug reaches the desired position relative to the ship, it is

advisable to maintain a parallel course with the ship to avoid substantial longitudinal forces and yaw moments that can adversely affect the tug's manoeuvrability.

**Keywords** - ship – tug interaction, forward and aft regions, HIRP, tug safety

## NOMENCLATURE

### *Nomenclature*

$C_N$	Yaw moment coefficient
$C_X$	Surge force coefficient
$C_Y$	Sway force coefficient
$F_r$	Froude Number, Tug; $\frac{u}{\sqrt{gL_t}}$
$g$	Acceleration due to gravity ( $9.81\text{m/s}^2$ )
HIRP	Hydrodynamic Interaction Region Plot
$L_s$	Waterline length of the tanker (m)
$L_t$	Waterline length of the tug (m)
$N$	Yaw moment acting on tug (Nm)
$u$	Fluid flow velocity (m/s)
$X$	Longitudinal force acting on tug (N)
$Y$	Lateral force acting on tug (N)
$\delta x$	Longitudinal distance between hulls (m)
$\delta y$	Lateral distance between hulls (m)
$\Delta x$	Non-dimensionalised longitudinal distance between vessels
$\Delta y$	Non-dimensionalised transverse distance between vessels
$\rho$	Density of water ( $\text{kg/m}^3$ )
$\nabla_s$	Volumetric displacement of the tanker ( $\text{m}^3$ )
$\nabla_t$	Volumetric displacement of the tug ( $\text{m}^3$ )

## I. INTRODUCTION

When a large ship is manoeuvred in restricted waters at low speeds, it is usually required to have an assisting tug or tugs in order to maintain its course and berthing safely. However, when a tug operates in close proximity to a larger ship, the hydrodynamic interaction effects induced on the tug could lead to danger such as collision between the vessels or the tug being run-over by the ship (Hensen, 2012). Hence, it is essential to understand the hydrodynamic interaction behaviour between the vessels to enable the tug and ship operators to take the required action to avoid such dangers. There are a number of published work addressing interaction effects between vessels operating in close proximity that investigate and provide information on (Sutulo et al., 2012):

- the qualitative behaviour of the hydrodynamic interaction effects;
- estimation of maximum loads, safe distances and velocities during vessel overtaking and encounter situations;
- the mooring line loads on a berthed vessel due to passing vessels;
- navigational accidents of vessels operating in close proximity;
- manoeuvring standards for tug and ship operators; and
- algorithms for ship handling simulators.

To date, most studies on the interaction behaviour available in the public domain (Newton, 1960, Vantorre et al., 2002, Pinkster and Bhawsinka, 2013, Lindberg et al., 2012, Zou and Larsson, 2013, Tuck and Newman, 1974, Lataire et al., 2009, Taylor, 1909) have investigated ships that are similar in size.

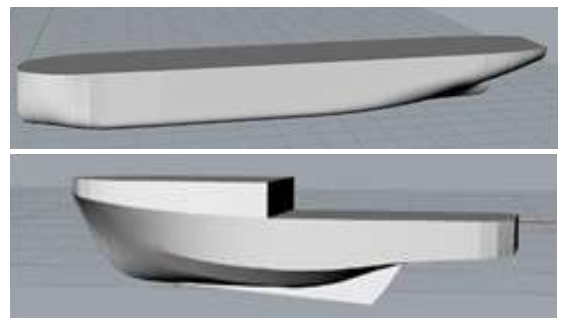
There is a limited number of studies (Dand, 1975, Simonsen et al., 2011, Geerts et al., 2011, Fonfach et al., 2011, Sutulo et al., 2012) that focus on the interaction behaviour of a tug (which is significantly smaller in size and thus more susceptible to the interaction effects) operating in close proximity to a large ship. However, most of these studies used either a tug operating at one specific location alongside the ship (e.g. the midship region) or only at one tug drift angle relative to the ship (usually with the ship and tug operating in parallel). Thus, the predicted results of the interaction effects were specific to certain locations and operating conditions, and thus do not provide a comprehensive view of the overall behaviour of the tug during such manoeuvres.

Previous work published by the authors (Jayarathne et al., 2017b, Jayarathne et al., 2017a, Jayarathne et al., 2016, Jayarathne et al., 2014) attempts to address these gaps by providing interaction information on a tug operating at various locations and angles of attack relative to a large ship.

These studies were aimed at developing comprehensive Hydrodynamic Interaction Region Plots (HIRP) to assist tug operators to identify safe operating envelopes for their tugs during ship-assist manoeuvres. In Jayarathne et al. (2016), the authors presented HIRPs for tugs operating around the midship region of a large ship at various lateral separations. However, as explained by Hensen (2003), the forward and aft regions of ships are the most critical areas for the tugs to operate and thus need careful attention. This study extends the previously presented HIRPs to include the forward and aft regions to provide a more comprehensive set of interaction effect data to assist tug operators during ship assist manoeuvres.

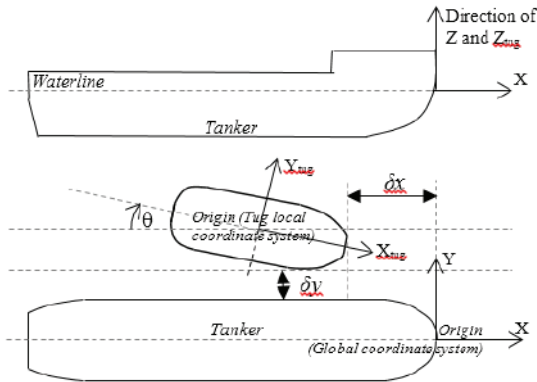
## II. CASE STUDY

The study utilised a MARAD F-series tanker and a typical stern drive tug hull, which were used previously by the authors (Jayarathne et al., 2016), with the hull geometries reproduced in Figure 1. Throughout the analysis, the tug was located on the port side of the tanker. Two different tug operating speeds: 3 knots (Tug length based Froude number,  $Fr = 0.09$ ) and 6 knots ( $Fr = 0.18$ ), were investigated in this study. These speeds represent the minimum and maximum tug operational speeds during usual ship assist manoeuvres (Hensen, 2003). The coordinate systems used for the study are given in Figure 2. The global coordinate system was used to obtain the tug's longitudinal and lateral forces, while the yaw moment was measured on the tug local coordinate system.



**Figure 1: 3D Hull forms: (Top) MARAD-F Series Tanker (Bottom) Typical stern drive Tug. [Not to scale]**





**Figure 2: Local (tug) and global coordinates systems, and vessel locations. [Not to scale]**

The forces, moment, and the longitudinal and lateral distance between the two vessels were non-dimensionalised using Eqs. 1 to 5 respectively (Fonfach, 2010, Simonsen et al., 2011, Jayarathne et al., 2017a, Jayarathne et al., 2016).

$$C_X = \frac{2X}{u^2 \nabla_i^{1/3} \nabla_s^{1/3} \rho} \quad (\text{Eq.1})$$

$$C_Y = \frac{2Y}{u^2 \nabla_i^{1/3} \nabla_s^{1/3} \rho} \quad (\text{Eq.2})$$

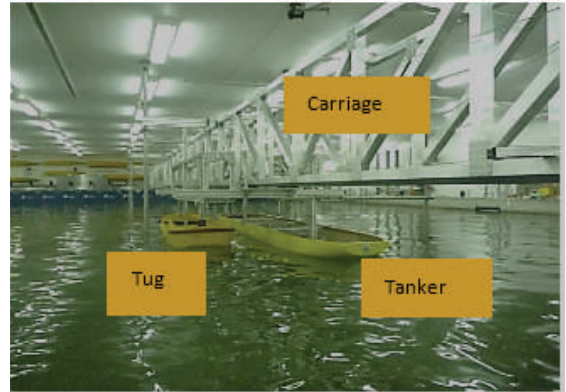
$$C_N = \frac{2N}{u^2 \nabla_i^{1/3} \nabla_s^{1/3} L_t \rho} \quad (\text{Eq.3})$$

$$\Delta x = \frac{\delta x}{L_s} \quad (\text{Eq.4})$$

$$\Delta y = \frac{\delta y}{B_s} \quad (\text{Eq.5})$$

with all symbols defined in the nomenclature.

The analysis was conducted using Computational Fluid Dynamics (CFD) simulations utilising the computational mesh presented in Jayarathne et al. (2016). The CFD mesh at model scale was validated using the results from the captive model tests conducted in the model test basin at the Australian Maritime College (AMC) (Figure 3).



**Figure 3: Experimental setup to measure the interaction effects between vessels in AMC's Model Test Basin**

The mesh model was then extended to full-scale conditions with a scale factor of 1:50 based on the Froude scaling technique, with a final mesh domain of 13.2 million shown in Figure 4. The full-scale CFD mesh (Jayarathne et al., 2016) was used to investigate the interaction effects induced on the tug operating within the forward region (i.e.  $\Delta x = -0.10$ ) and the aft region (i.e.  $\Delta x = -0.75$ ) alongside the tanker at three different lateral separations and seven different drift angles, as outlined in Table 1.



**Figure 4: The final full scale 13.2 million CFD mesh model of the tug and ship.**

The commercial CFD code, Star-CCM+<sup>®</sup> was used to investigate the test scenarios outlined in Table 1 via Reynolds Averaged Navier-Stokes (RANS)-based simulations with the Shear Stress Transport (SST) turbulence model. The computational domain used in the Star-CCM+<sup>®</sup> simulations is shown in Figure 5.

**Table 1. Cases investigated for the tug operating at forward (  $x = -0.10$ ) and aft (  $x = -0.75$ ) regions alongside the tanker.**

Drift Angle between hulls	Distance between hulls		
	$\delta y = 1 \text{ m}$ $\Delta y = 0.03$	$\delta y = 18.225 \text{ m}$ $\Delta y = 0.5$	$\delta y = 36.45 \text{ m}$ $\Delta y = 1.0$
0 Degree	✓	✓	✓
15 Degrees	✓	✓	✓
30 Degrees	✓	✓	✓
45 Degrees	✓	✓	✓
60 Degrees	✓	✓	✓
75 Degrees	✓	✓	✓
90 Degrees	✓	✓	✓

The free surface in the CFD simulation was modelled as an Euler Multiphase using the volume of fluid (VOF) technique.

Verification and validation studies of the simulation model were previously presented by the authors in (Jayarathne et al., 2017a, Jayarathne et al., 2017b) showing good agreement between the interaction coefficients for the model scale CFD and model scale EFD results, and full-scale CFD results based on Froude scaling.

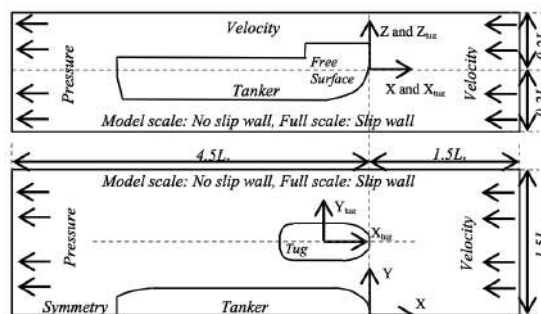
The difference of the coefficients was less than the experimental uncertainties of 7%, 9.4%, and 7% for the longitudinal force, lateral force, and yaw moment respectively. The model scale and full-scale predictions of the interaction effect coefficients were in good agreement (within 8%) thus providing confidence in the CFD model to be extended to the full-scale conditions of this study.

### III. HIRP RESULTS

The coefficients of the interaction effects when the tug is positioned alongside the tanker at the different drift angles and lateral and longitudinal locations as given in Table 1 are presented below. It includes a comparison of the forces and moments obtained by simulating the tug in open-water and in close proximity to the tanker to identify the significance of the tanker’s presence on the tug’s manoeuvrability. Figure 6 illustrates the HIRPs of the tug operating around the aft and forward regions of the tanker.

From Figure 6 it is seen that when the tug is at the aft region of the tanker ( $\Delta x = -0.75$ ), its longitudinal force is similar to the open-water tug until a drift angle of 15 degrees for all three lateral separations. The same behaviour is observed when the tug is at the forward region of the tanker, i.e.  $\Delta x = -0.10$ . When the drift angle increases above 15 degrees, there is a deviation of the longitudinal force from that for the open-water tug and the maximum force is seen at a drift angle of 90 degrees for both the aft and forward regions. It is also observed that this variation is greater for the forward region. Therefore tug operators should expect a greater change in tug resistance when manoeuvring within the forward region of the larger vessel.

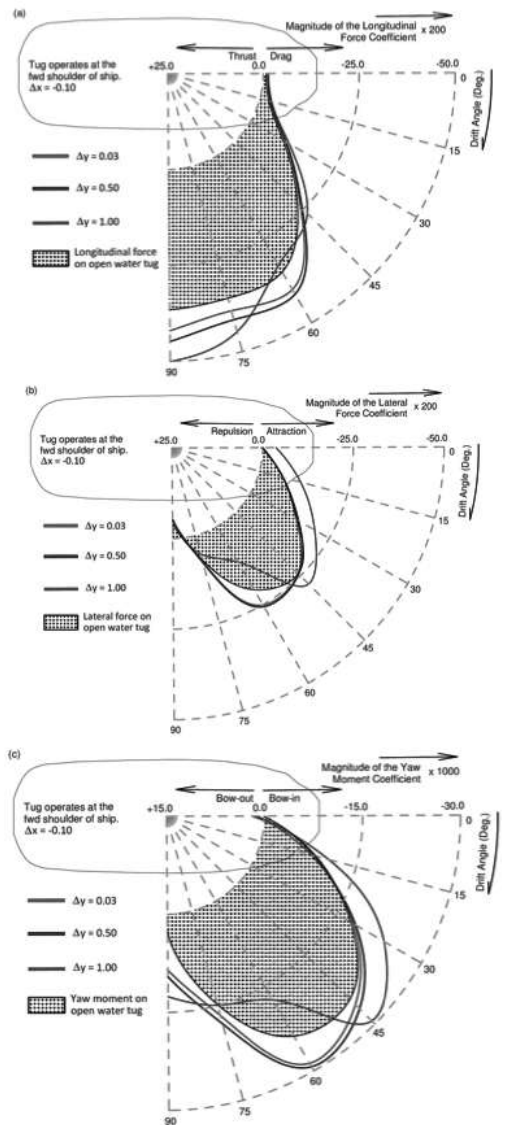
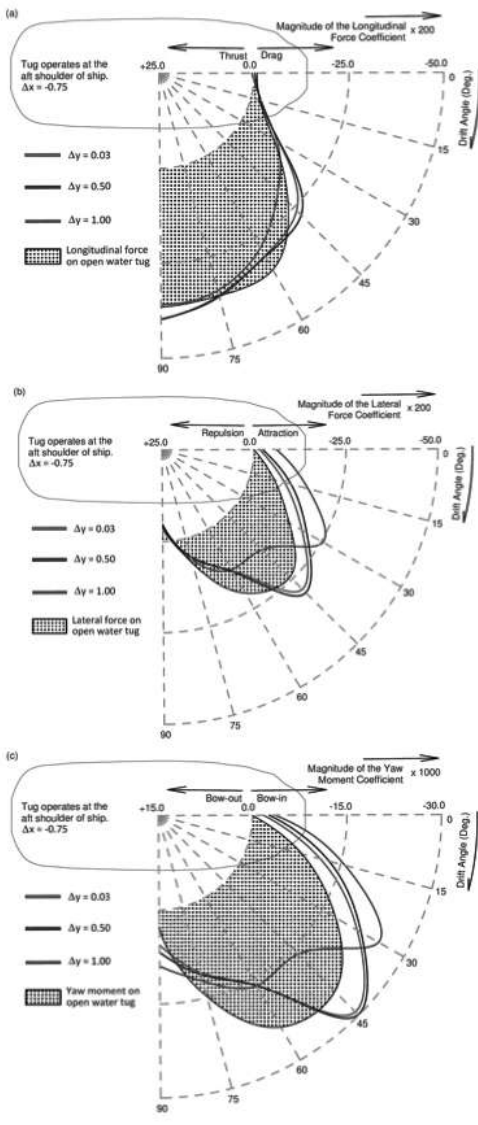
Considering the lateral force on the tug with respect to the drift angle in the aft region of the tanker, the suction force peaked at 30 degrees for  $\Delta y = 0.03$  and 45 degrees for  $\Delta y = 0.50$  and  $1.00$ ; decreasing steeply thereafter as the drift angle increases.



**Figure 5: Computational domain used in Star-CCM+® simulations. [Not to scale]**

**Tug near the aft region of tanker ( $\Delta x = -0.75$ )**

**Tug near the forward region of tanker ( $\Delta x = -0.10$ )**



**Figure 6: Hydrodynamic Interaction Region Plots (HIRP) showing the forces and moments on the open-water tug, and on an interacting tug operating at the aft and forward regions of the tanker. a) Magnitude of the longitudinal force coefficient; b) Magnitude of the lateral force coefficient; c) Magnitude of the yaw moment coefficient.**

The yaw moment follows the same trend of the lateral force with respect to drift angle. Therefore, tug operators should avoid being close to the critical drift angles between 30 and 75 degrees due to the difficulty in predicting the variation of the forces due to the interaction, as this increases the chances of the vessel reacting contrary to the commands given. From zero to 15 degrees and 75 to 90 degrees, the lateral force and yaw moment for the interacting tug follow a pattern similar to the open-water tug, thus making it easier for tug operators to predict the variation of the forces and moments due to the interaction. However, it should be remembered that between the drift angles of 75 and 90 degrees, the tug experiences the maximum longitudinal force which can affect its position keeping ability. Therefore, the tug should maintain a drift angle of less than 15 degrees near the aft region of the tanker to minimise adverse interaction effects.

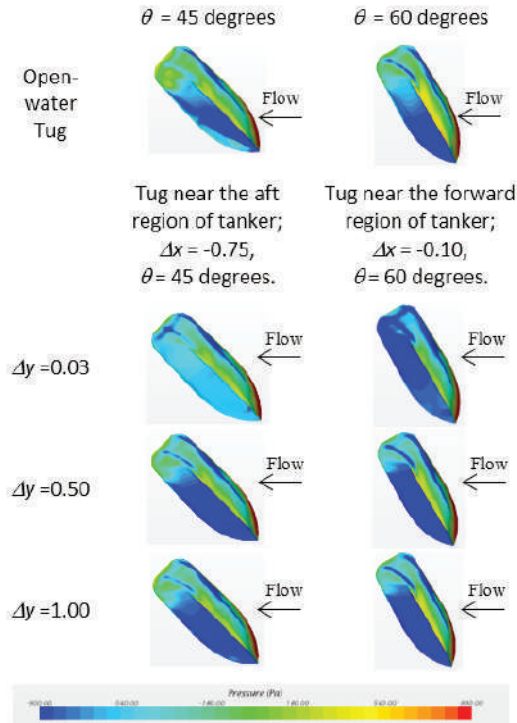
When observing lateral force and yaw moment on the tug with respect to drift angle in the forward region of the tanker, the interaction behaviour follows a similar trend to the aft region. The exception is that the suction force and yaw moment peak at 45 degrees for  $\Delta y = 0.03$  and 60 degrees for  $\Delta y = 0.05$  and  $0.10$ . It can this be summarises that when a tug is operating around the forward or aft regions of a larger ship, tug operators can avoid excessive lateral forces and moments due to the interaction if they maintained a drift angle less than 15 degrees.

#### IV. FLOW VISUALISATION

Figure 7 illustrates CFD pressure contours on the tug hull at a drift angle of 45 degrees around the aft region of the tanker and at 60 degrees around the forward region of the tanker. These represent locations where critical changes in forces and moment are observed in the HIRPs (see Figure 6). Hull pressure contours of the open-water tug are also presented to highlight the interaction effects due the differences in the pressure field.

As seen in the figure, when the tug is at the stern region of the tanker ( $\Delta x = -0.75$ ) and the lateral separation is the smallest ( $\Delta y = 0.03$ ), the pressure on the tug's leeward side is more than that of the open-water tug. This is due to the tug operating around the aft region of the tanker resulting in a comparatively higher pressure due to the pressure recovery in that region. This high pressure decreases the longitudinal and lateral suction forces acting on the tug in comparison to that in an open-water condition. In addition, at  $\Delta y = 0.03$ , the pressure distribution along the

tug's length is less than on the open-water tug. This in turn reduces the bow-in yaw moment on the tug. In contrast to the  $\Delta y = 0.03$  separation, at  $\Delta y = 0.50$  and  $1.00$  the hull pressure is less on the leeward side. Therefore, at these lateral separations, the forces and moment become larger than what is experienced in the open-water condition.



**Figure 7: CFD hull pressure contours for a tug at a drift angle ( $\theta$ ) of 45 in the aft region and 60 degrees in the forward region of the tanker.  $\Delta x$  and  $\Delta y$  are the non-dimensionalised longitudinal and lateral separations respectively.**

From Figure 7 it is seen that when the tug is in the forward region of the tanker, a drift angle of 60 degrees and  $\Delta y = 0.03$ , the pressure at the bow of the tug on the leeward side is higher compared to the open-water tug. This is due to the small gap between the vessels, which hinders the flow past them, and thus increasing the pressure at the location. In addition, the pressure on the tug's stern is well below the pressure on the stern of the open-water tug. As a result, there is a reduction in the lateral attraction force and the bow-in yaw moment, when compared with that on the open-water tug.

As seen in the pressure contours on the tug hull, when the

lateral separation is increased to  $\Delta y = 0.50$  and  $1.00$ , the pressure on the tug's leeward side is reduced compared to the open-water tug. Therefore, as seen in Figure 6, when the tug is drifted to 60 degrees around the forward region of the vessel, the magnitudes of the lateral attraction force and bow-in yaw moment are at a maximum, which in turn increase the danger to the tug during close quarter manoeuvres.

## V. CONCLUSION

This study presents the hydrodynamic interaction effects induced on a tug operating at the forward and aft regions of a larger ship during a ship-assist manoeuvre. It was carried out through a CFD simulation study, using a previously validated CFD simulation model (Jayarathne et al., 2016). Interaction effects on the tug were determined at two regions of the ship for difference lateral separations, tug drift angles, and two speeds. The results were presented on Hydrodynamic Interaction Region Plots (HIRP) enabling the tug operators to identify safe operational envelopes for a tug to approach the forward and aft regions of the larger vessel during such manoeuvres.

The results revealed that drift angles ranging from zero to 15 degrees and 75 to 90 degrees present the least interaction lateral force and yaw moment. However, within the 75 to 90 degrees drift angle range, the longitudinal force induced on the tug is relatively high. Thus, a tug operating within this drift angle range will struggle to maintain its position relative to the ship due to strong longitudinal forces acting on it. It is therefore recommended that a tug approaches the forward and aft regions of a larger ship along a path that results in a drift angle between zero to 15 degrees. This will result in minimum interaction between the vessels that could otherwise adversely affect the trajectory and behaviours of the tug. Once the tug reaches these regions of the ship, it is the best to align and maintain the tug parallel to the ship as much as possible, thus reducing the interaction effects as the vessels progress forward together. Furthermore, the study identified drift angles between 30 to 60 degrees as a critical range, where the interaction behaviour is most detrimental to the tug. It is therefore prudent to attempt and maintain the tug drift angle within the safe ranges, i.e. between zero and 15 degrees, while moving quickly through the adverse ranges if required.

In future work, the current results will be extended to include varying longitudinal locations of the tug, thus providing data for a range of longitudinal and lateral

separations as well as tug drift angles. The results will be used to develop explicit Hydrodynamic Interaction Region Plots (HIRP) to determine safe operational envelopes for tugs to operate during ship-assist manoeuvres.

## ACKNOWLEDGMENT

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# TRENDING OF VIBRATION SPECTRUM IN MARINE DIESEL ENGINE, MARINE GEAR BOX AND VARIATIONS WITH ROTATIONAL SPEEDS

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**Abstract** - Noise and vibration on board ships may cause discomfort to passengers and crew. It may also impair the efficient execution of the crew's duties, be the cause of damage to sensitive equipment, structural parts of the ship and cargo, and even compromise the safety of the vessel. In military scenario, this may influence the combat readiness of the vessel too. Nowadays, people on board are less willing to accept discomfort due to noise and vibration, leading to increasingly strict requirements. As these are usually not easily met, noise and vibration have become important factors in ship design. Noise and vibration levels are determined by the characteristics of source, transmission and receptor. Low frequency noise and vibration are difficult to damp and addition of mass and stiffness in the 'remedial' design stage is costly, and an effort multiplier. Therefore, noise and vibration problems must be avoided through identification and treatment of the major sources as and when found.

It is appropriate that the principal vibration exciting sources be addressed first, since with high excitation levels excessive vibration can occur almost independently of system structural characteristics. In general, the major sources are the high-speed diesel main engine and the propeller (impeller). Hull excitations are generally considered to give less excitation than diesel engines. Thus, in this section, attention is paid to the excitation of the high speed main diesel engine.

The main source of vibration generator is the propulsion system for a ship. Correct identification of its signature and spectrum with the trending behaviour is a better method to predict whole ship's vibration levels. In order to identify the same, a fast attack craft fitted with 02 Nos

2000 hp each engines were earmarked to conduct trials. Sea trials at following conditions had been carried out.  
Sea State : 1-2, 2-3;  
Loading Condition : Full Load, Half Load;  
Wind Condition : Moderate < 15 knots;  
Sea Direction : Ahead, Astern

**Key words** - vibration spectrum, vibration analyser, marine engine, thrust bearings

## I. INTRODUCTION

Prediction and diagnostics of rotating machinery using the envelope spectrum of high frequency vibration excited by internal forces of the engines is becoming widely used by many experts. In recent years, automatic diagnostic systems based on this method have been developed mainly for rolling element bearings. These systems can provide detailed diagnostics and condition prediction of a bearing by a single vibration measurement. Automatic diagnostic systems for simultaneous diagnostics of gears and rolling element bearings in gear transmissions have also been developed. But until recently, there were no diagnostic systems that used envelope spectra of random vibration for detection and identification of defects in fluid film/ thrust bearings. The typical use of standard enveloping methods developed for the diagnostics of rolling element bearings in the diagnostics of thrust bearings are discussed in this paper. Methods for comparison of rolling element results with thrust bearings of a marine diesel engine and rolling and gear elements of a marine gear box are analyzed together with the practical results achieved in this field. The results that are discussed in this paper were practical outcomes of a vessel whilst patrolling.

The aim of this study was to identify and differentiate the spectrum patterns generated from rolling element and thrust bearings of marine engines and gear boxes to identify an optimum maintenance schedule in order to minimise the risks of failures originated from vibration defects.

## II. METHODOLOGY

Vibrations of the machineries of the craft are analyzed using Fast Fourier Transform (FFT) algorithm in two frequency bands, the first from 0 to 100 Hz, and the second from 100 Hz to 10 kHz. Taking into account the overall machinery readings, low and medium frequency ranges of the vibrations are of particular interest, and therefore the limits of the above frequency bands are defined. Particular interest is in the low frequency band, which is defined from zero to 100 Hz.

Vibrations – displacement, velocity and accelerations were measured during the movement of the vessel in the measuring points defined.

### A. Vibration Analyser and Software

The trial team used 02 Nos vibration data analysers (Frequency Range: 0 – 40,000 Hz) integrated with supported software system. The averaging used is 5 times and FFT uses Hanning window method for data filtering. One analyser is having two channels and the sampling frequency for each channel is 102.4 kHz.

### B. Measurement Procedure(As per ISO 6954: 2000)

- a. Measurements were recorded in all three directions at a minimum of two locations on each deck. At other locations, measurements are only required in the vertical direction.
- b. The combined frequency weighting curve according to ISO 2631-2 was applied to all measurements irrespective of their direction.
- c. The frequency range evaluated was 1 Hz to 10000 Hz. (Analysed separately in low, medium and high frequency ranges)
- d. The measurement duration was above 1 min. for all machinery locations. For hull locations measurement duration of at least 2 min is required.
- e. The result of each measurement shall be the overall frequency-weighted r.m.s. value.

Measurements were recorded in radial direction at three locations near the crank shaft.

### C. Locations for Data Recording

**Table 1. Locations onboard Ship**

Sr No	Location	Direction
<b>Machinery Locations</b>		
1	Gear Box Free End (G/B F/E)	Vertical Horizontal Axial
2	Gear Box Drive End (G/B D/E)	Vertical Horizontal Axial
3	Main Engine Free End (M/E F/E)	Vertical Horizontal Axial
4	Main Engine Drive End (M/E D/E)	Vertical Horizontal Axial

### D. Engine Specifications

Cylinder arrangement	: 60 deg V
No. Of Cylinders	: 16
Stroke	: 160 mm
Bore	: 132 mm
Cylinder capacity	: 2.19 dm <sup>3</sup>
Displacement (Total)	: 35.04 dm <sup>3</sup>
Turbo charged	
Compression Ratio	: 15:1
HP	: 1200 at 1500 RPM
KW	: 1050 KW
Max RPM	: 1800

### E. Vessel Particulars

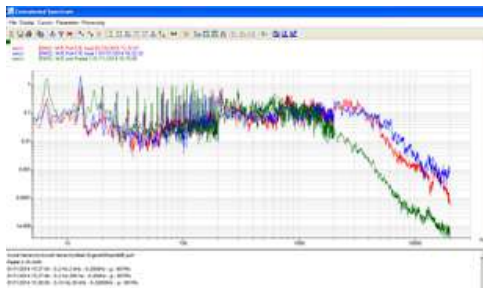
Length overall	- 24.05 m
Breadth, moulded (max)	- 5.7 m
Draught Max	- 1.45 m
Half load	- 1.3 m
Minimum	- 1.15 m
Displacement at full load	- 59.65 Ton
Max. Speed at 100% engine	- 50 kn (knots)
Class	- Fast Attack Craft

## III. CONDUCT OF SEA TRIALS AND SALIENT RESULTS

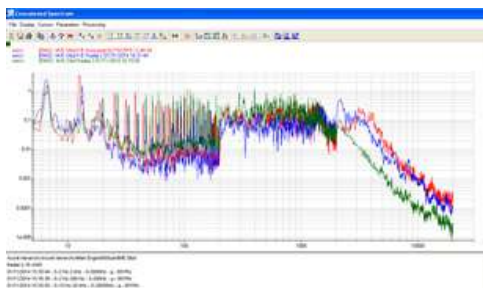
The trial team focused on recording data at two fixed engine RPMs and analysing the spectrums resulted from earmarked machinery locations.



**A. Main Machinery Vibration Spectra at 800 rpm**

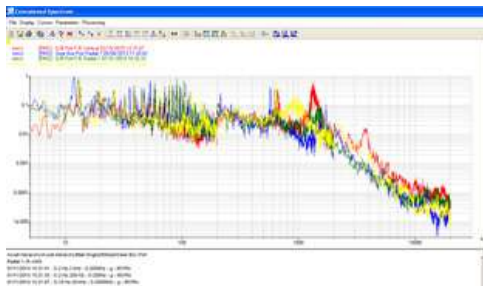


**Figure 1 : Port Main Engine Free End Readings**



**Figure 2 : Stbd Main Engine Free End Readings**

**B. Marine Gear Box Spectra at respective 800 rpm**



**Figure 3: Port Gear Box Free End Readings**



**Figure 4: Stbd Gear Box Free End Readings**

The method of rolling element bearings predictions by the spectrum of high frequency vibration envelope is based on the analysis of characteristics in the formation of friction forces in good and defective bearings as well as in the features of shock pulses that appear in the interaction of rolling surfaces with cavities, spalls, or cracks in the bearing elements.

The vibration spectra on marine engine and connected gear box were separately recorded in order to compare the differences between rolling elements and thrust bearings in the aspects of both numerical and graphical comparison. It was displayed from the spectrum patterns that 10 -1000 Hz the spectrum covers dominant crank shaft vibration signatures in case of engine and drive gear signature in case of gear box. The friction forces depend on the rolling friction coefficient and the load on rolling elements. In good bearings, the friction is uniform in time, i.e. it does not depend on the rotation angle of the rotating race or of the cage. As a result, the friction forces, together with the random vibration excited by them, become amplitude modulated. In bearings with non-uniform wear of inner and outer races and rolling elements, the friction coefficient in turn depends on the rotation angle of rotating race and cage which results in similar amplitude modulation of the friction forces and the resultant high frequency vibration. Finally, shock pulses in bearings with cavities and cracks on rolling surfaces and races produce vibration as well. On the resonant frequencies of rolling elements and races, this vibration is actually attenuated self-oscillations that should not be considered as random vibration. At other frequencies, shock pulses excite random, fast attenuated vibration that is also modulated in amplitude.

The resulted spectrum patterns of gear boxes (at 800 rpm) on four days i.e. trending pattern ( 04 Sep 2013, 11 Jan 2014, 31 Jul 2014, 19 Feb 2015) had seen not much of a deviation from the standard pattern except for few isolated valleys and peaks. This had been a healthier sign of a marine gear box with a demonstration of trouble free operation more than two years of continuous operation.

**IV. COMPARISION OF RESULTS**

High frequency random vibration is excited by friction forces in both rolling element and thrust bearings. When defects of friction surfaces develop in these types of bearings, the friction forces and high frequency vibration acquire amplitude modulation and thus bearing defects can be detected by the analysis of envelope spectrum of

this vibration. In the same situation, in the case of thrust bearings, there are much more problems in the detection and identification of defects than in rolling element bearings. The first problem is connected with the limited diagnostic information that can be derived from the modulation frequencies. Rolling element bearings have at least 4 types of friction surfaces with different rotation speeds. These are outer and inner races, rolling elements, and the cage.

In case of thrust bearings, there are only two friction surfaces and one fundamental frequency. The second problem is due to the characteristics of pressure pulsation formation in the lubrication layer and the vibration excited by this pulsation. The pulsation power is determined by the velocity gradient in the lubrication layer, but it increases not only with rotation speed, but also with the decrease of lubrication layer thickness. The thickness of the lubrication layer, in turn, depends on the bearing design and on the relative position of the shaft axis and bearing shell axis.

In a number of bearings, the shaft axis moves and, as a result, the high frequency vibration may be modulated even in good bearings. The third problem occurs in the detection of the defect severity. In the case of thrust bearings, not only the modulation index in the envelope spectrum, to be considered, but the thickness of the lubrication layer (and bearing thickness) as well. Reliable information about the thickness of the lubrication layer, as a rule, is not available for a user, not generally provided by manufacturer, thus the levels for defects have to be adapted for every machine type that has some special design characteristics of the bearings or of the machine. Following many years of investigations and practical diagnostics of bearings in rotating machines using the envelope spectrum of high frequency vibration, it was concluded that the above problems are difficult to be solved in practice.

A number of diagnostic symptoms were found which allow successful condition diagnostics of fluid film bearings. These are based on the characteristics of shaft journal oscillations in the lubrication layer of the fluid film bearing. Consider three of these characteristics. The first characteristic is the possible appearance of short pulses with increased oil pulsation during the movement of oil wedge on the bearing shell surface. The rotation of the oil wedge is an indication of, first of all, of shaft wobbling. In a good bearing, such a pulse can appear when the oil wedge passes joints of the shell sectors. In the case of a worn bearing, when the oil wedge passes non-uniform

wear zones on the bearing shell, cracks, and so forth, such short pulses can be considered as shock pulses in fluid film bearings analogous to the shock pulses in rolling element bearings. The second characteristic is possible appearance of shaft vibration at frequencies different from the harmonics of rotation speed. Most often, this is a self-sustained oscillation of the shaft in bearings with loose clearances or defects in the oil supply system. In most practical cases, self-sustained oscillations of the shaft synchronize with one of the sub-harmonics of the rotation speed.

Sometimes it is observed that the pendulum shaft oscillation in very loose bearings which also, as a rule, synchronize with one of rotation speed sub-harmonics. And the third characteristic is the appearance of low frequency random oscillations of the shaft relative to the bearing shell surface. This situation can be found in the bearings with non-uniformly worn shells. These oscillations are defined by the unstable shape of the oil wedge with small and random changes. This can be detected by changes in the shape of the envelope spectrum and background level increases on frequencies below the shaft rotation speed. Such increases of background level in the envelope spectrum should be considered as an effective symptom of the bearing shell wear. The use of the above diagnostic symptoms allow the thrust bearings diagnostics without needing a relative displacement transducer installation in the bearing unit.

The experimental concern of the study is to comply with the periodicity of measurements. The intervals between measurements can be rather long, about a few months when the service life of the bearing is 5 to 8 years and when the machine is operated in its standard modes. If the above conditions are met, it is enough to make 10 to 20 measurements of the high frequency vibration envelope spectra during the whole service life of a bearing to eliminate its un-predicted failure. The levels for defects that are used for the estimation of the detected defect severity in rolling element bearings can be similar for all types of machines and bearings. They monotonously increase with the increase of rotation speed and bearing dimensions.

A number of different problems occur in the diagnostics of thrust bearings using an envelope spectrum of high frequency vibration. These problems are solved by the added analysis of diagnostic information from the auto spectra of bearing housing vibration. The first problem is connected to the design characteristics of some machines where the shaft motion oscillates in the stationary bearing

shell, even with no defects present. In this case, an envelope spectrum at this bearing will contain harmonic components proportional to the rotation frequency in spite of the absence of defect.

The vibration measurements, in turn, should be done more often, than rolling elements. The second problem is closely connected with the variety of fluid film bearings designs, each of which has its own lubrication layer thickness. For this reason, similar defects in the bearings with different lubrication layer thickness lead to different changes in the normalized thickness and thus, different modulation of random vibration. The best solution is to correct levels for defects according to the data derived from the analysis of autospectra, i.e. the increase of vibration components after the detection of severe defects in similar bearings of other engines. For the reasons discussed above which are different from the rolling element bearing case, fluid film bearings are best diagnosed by the parallel analysis of autospectra and envelope spectra of the bearing shield vibration.

## V. CONCLUSION

Comparative analysis of possibilities for rolling element and fluid film bearings (in marine gear boxes and engines respectively) diagnostics by the analysis of high frequency vibration envelope spectra presents the following conclusions:

- (I) Vibration diagnostics is the most efficient method for detection, identification and differentiation of incipient defects in rolling element and thrust bearings. Analysis and predictions on rolling element bearings are comparatively easier than thrust bearings. However, it is recommended to use same analysis technique for both the instances.
- (II) The typical interval between measurements for rolling element bearings in absence of detected defects is several months (6 - 12 months) and for thrust bearings is less than that. The levels for the detection

of defects in rolling element bearings and estimation of their severity are nearly independent on the machine/ engine and bearing design. Only some small dependence of levels for defects on the rotation speed and bearing dimensions exists. For machines with thrust bearings, the levels for defects also depend on the bearing design.

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# PRELIMINARY CONCEPT DESIGN OF AN AFFORDABLE COASTAL PATROL CRAFT FOR SRI LANKA NAVY

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**Abstract** – The post-war role and the mission of Sri Lanka Navy has become more multi-dimensional. Newer challenges such as piracy, fisheries law enforcement, human trafficking, drug trafficking, and marine pollution prevention have become major focus areas for Sri Lanka Navy. To successfully counter these new challenges the Navy has broadened its spectrum of operations by forming the Sri Lanka Coast Guard and more recently forming its first Marine Battalion. With the introduction of these new units, there will be an increased demand for a new fleet of patrol crafts. Due to budgetary constraints a cost effective way to approach this situation is to design a single class of patrol crafts that has multi mission capabilities which can perform most of the operations carried out by the Sri Lanka Navy, Sri Lanka Coast Guard and the Marine Battalion.

This research paper is about designing an affordable multi mission capable patrol craft, utilizing modularity concept and a planing hull design. The initial step in this design process was to get an understanding of the Sri Lanka Navy, Coast Guard and Marine Battalion fleets and the specific missions of each service. Then key design parameters such as length, endurance, maximum speed were recognized through this initial research.

Then a similar ship analysis/market survey was carried out to select other principal dimensions and coefficients of form. After all the key design features are decided, a preliminary concept design of the ship hull form was created utilizing design software. Further analysis was carried out to generate initial hydrostatics and stability curve of the vessel, and resistance and powering calculations. Since cost reduction is the most vital aspect in this study to become an affordable design a lot of emphasis

was put on the modularity concept and the learning curve concept.

**Keywords** - Planning hull, Patrol craft, Cost effective, Modularity

## I. INTRODUCTION

After three decades of brutal war Sri Lanka Navy is broadening its horizons and improving the capabilities to become a professional and more competent naval force. In this scenario expanding the naval fleet is one of the key priorities for the Navy and improving the contemporary naval design is of paramount importance in this context. The primary goal of this research paper is to come up with a preliminary concept design of a coastal patrol craft that could fulfil most of the current mission requirements of the Sri Lanka Navy and the Sri Lanka Coast Guard. These missions cover a wide range of maritime safety, maritime security and maritime stewardship aspects. Since each of these missions require specific design features or specific qualities such as high manoeuvrability, ability to reach high speeds, shallow draft etc. It is important to have a thorough understanding about all the missions carried out by the Navy and the Coast Guard. These missions include but not limited to coastal patrol, search and rescue operations (SAR), anti-terrorism operations, reconnaissance, logistic/resupply, medevac, amphibious missions, oil spill response, drug interdiction operations, humanitarian assistance, law enforcement, peacekeeping, illegal immigrant interdiction and non-combatant evacuation operations.

If Navy and Coast Guard is planning to design multiple classes of crafts (patrol craft, rapid response boat, life boat, amphibious landing craft, etc.) catering to all these

requirements, it would be a costly and time consuming endeavour. Therefore designing a single class of vessel that could perform most of the aforementioned missions a lot of expenditure could be saved during the preliminary design stage, and also during the manufacturing stage.

To achieve cost effectiveness, efficiency and multi mission capability a couple of design concepts will be explored in this preliminary concept design study. A planing hull model will be utilized in this preliminary study due to its ability to achieve high speeds, and also its efficiency in planing mode. The concept of employing mission specific removable payload modules will also be utilized in this design to economize the space of the vessel while enhancing the multi mission capability of the Coastal Patrol Craft.

### A. Planing Craft

The definition of planing, i.e. “Planing is the mode of operation for a waterborne craft in which its weight is predominantly supported by hydrodynamic lift, rather than hydrostatic lift (buoyancy)” According to [3], the planing hull has evolved to overcome the inherent hydrodynamic limitations associated with high-speed operation of the traditional displacement hull. When increasing the speed of planing hull, developed positive dynamic pressure support to decrease the draft. Hence craft can attain higher speeds despite of wave generated. The principal parameters affecting the performance of planing hulls [3] are:

- Length-beam ratio, LP/BPA, where the mean beam over chines BPA =  $AP/LP$ .
- Size-weight ratio, defined by the coefficient
- Longitudinal position of CG from center of area of AP.
- Deadrise and its variation along the length.
- Longitudinal curvature of buttock line BPA/4 from CL.
- Shape of chine in plan.
- Shape of sections.

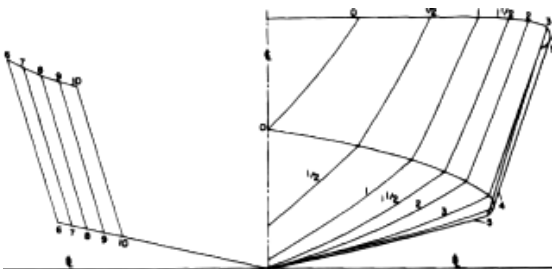


Figure 1: Lines of stepless planing hull-series 62 [3]

A theoretical approach to planing craft design is undertaken especially by Savitsky (1964) and by Hadler (1966). Savitsky brought out formulas for calculating the lift and drag forces while Hadler presented a method to predict the hull performance using Savitsky's formulas to calculate hydrodynamic forces and open water diagram to evaluate the propeller forces [3].

As a reliable approach to this study, Savitsky (1964) and Hadler (1966) studies are helpful formulating our design in a systematic way.

### B. Concept of Modularity

The concept modularity is a novel concept that is being employed in modern naval forces as a mean of reducing the vessel size while retaining multi mission capability. The basic idea of modularity is instead of permanently fitting a vessel with equipment required for all the missions, there will be a space or spaces assigned in the vessel that could accommodate mission specific removable payload modules (medical equipment, oil spill response equipment, extra weaponry and ammunition, SAR equipment, etc.). These mission specific payloads could be easily fitted and removed and are of the same standardized size. The only difference in these modules will be the content of each of the module. The payloads could be stored, and maintained in naval bases around the country, always in standby condition. Thus when any emergency occur a patrol craft or crafts could be fitted with the required module immediately and deployed. As patrol crafts often operate as a flotilla they could respond to a situation that requires different mission capabilities simultaneously by fitting different mission payloads on each craft.

Even though mission specific mission module is a relatively novel design concept, it has been proven successful and has been employed by some of the most advanced naval forces around the globe [8, 9]. A couple of examples for the utilization of this concept are the StanFlex modules used by the Royal Danish Navy (Kongelige Danske Marine, KDM) and the Littoral Combat Ship mission modules used by the United States Navy [8, 9].

StanFlex modules were first introduced in the 1980s, by the KDM as a solution to the successful replacement of several classes of minor war vessels with a single class of multi-role ships. These modules are standardised containers that could contain weapon systems and equipment. These modules can be easily fitted in to and removed out of the empty slots on board the ships. Due to the success of these

StanFlex modules most of the KDM ship classes employ this concept [8].

Littoral Combat Ships are one of the smaller warships of the United States Navy and was designed in order to counter small surface craft attacks, and for counter terrorism operations. The speciality of this ship is its ability to respond to a wide array of situations utilizing its mission specific modules [9].

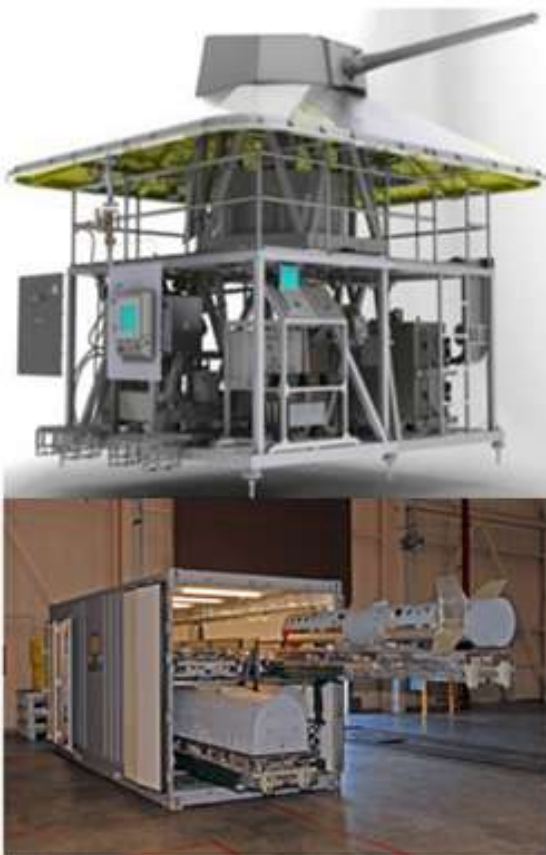


Figure 2: Modular mission packages of the Littoral Combat Ship [9]

C. Effects of Learning Curve

Since cost-effectiveness is one of the major driving factors in this design process, it is necessary to emphasize on the rationale behind designing a single class of patrol craft that has multi mission capabilities instead of designing several classes of patrol boats to perform specific mission. Firstly

this could save cost during the preliminary designing stage, since there will be only one final design that will be implemented. But the major cost savings will occur during the manufacturing stage.

During the manufacturing phase the principle of learning curve will decrease the manufacturing cost of the follow up boats due to the experience gained during the manufacture of the earlier boats. Spicknall (1995) states that “The traditional experience curve model of learning and improvement is founded on the presumption that individuals and organizations learn and performance improves solely as a result of experience gained through repetition of similar lines.” This article also provides an experience curve function as;

$$y_n = a \cdot n^b$$

(Eq. 1)

Where;

- n            Number of units of interest
- $y_n$         Objective measure of the performance
- a            Value of y for the first unit produced
- b            Exponent derived from regression analysis of historical data [7]

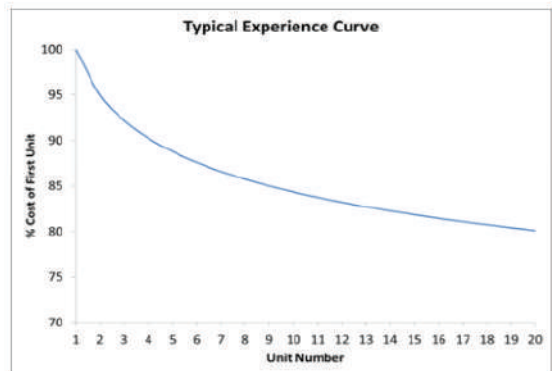


Figure 3: Typical experience curve [7]

Figure 3 shows a typical experience curve where a=100%, and b=-0.074. This learning curve indicates that to exploit the full advantage of the experience gained through the repetition and specialization, a considerable amount of units has to be produced. Thus it is better to design a single class of patrol boats, and keep manufacturing them while making them multi mission capable through modularity than designing multiple classes of boats to meet specific mission requirements.

## II. METHODOLOGY

### A. Top Level Requirements

During the first phase of this research the top level requirements or the key parameters such as the length, endurance, and maximum speed of the Coastal Patrol Craft were identified based on the mission requirements of the Navy and the Coast Guard. Since it is unrealistic to design a vessel that fulfills each and every one of these mission requirements, compromises and trade-offs were made accordingly. The three top level requirements identified as the most important in this initial phase were the endurance, maximum speed, and the length of the patrol craft. During this initial research stage we identified the need of a new Coastal Patrol Craft for the Coast Guard and the Marine Battalion, the two newly formed branches of the Navy. The missions of these two branches are highly likely to be in the coastal waters for the next few years until they become fully fledged organizations with offshore capabilities. Thus the maximum endurance required for these patrol crafts are approximately 200 NM. Since the missions of both these units include rapid action and rapid deployment, (Ex: drug interdiction, anti-piracy missions, amphibious missions etc.) these boats should be able to achieve a maximum speed of approximately 40 knots.

In order to achieve this maximum speed, it was decided that the design of the patrol craft has to be a planing hull. Planing hull design will also result in a decrease in the draft and this is also critical especially since marines usually engage in amphibious operations and this design could operate in shallow water conditions. Since these boats are coastal patrol vessels the crew size will be around 10-15 (crew and troops) and thus the projected length of the craft is around 10-12m. These parameters are the three top level requirements that were utilized as the key parameters of this research. Based on these three parameters a market survey and a similar ship analysis were carried out to determine the other dimensions of the Coastal Patrol Craft. During market survey/similar ship analysis nine boats were selected as potential parent hull for the Coastal Patrol Craft. These boats mostly included military vessels but a couple of commercial vessels were also selected based on the performance of their planing hulls. The particulars that were focused on this preliminary study were the length, beam, displacement, maximum speed, cruising speed, endurance/range, propulsion power, crewing, whether the boat carried armament, planing hull or not, employed a rigid inflatable collar or a foam collar or not, and finally the missions carried out by these boats.

The dimensions that were obtained during this market survey/similar ship analysis were catalogued and then compared using ratios. These ratios included maximum speed vs length, length vs beam, beam vs draft, power vs. displacement, and displacement vs. draft etc. The aim of this process was to select principal dimensions of the Coastal Patrol Craft that are within acceptable limits. One of the major difficulties faced during this process was the lack of market survey data regarding the planing aspects of the selected similar boats. Design data regarding deadrise angle, chine, aspect ratio, location of Longitudinal Center of Gravity, coefficients of forms were virtually non-existent for the selected vessels. Thus theoretical knowledge was used in determining those parameters during the design of the hull model. Based on the available dimensions of the similar boats the Small Unit Riverine Craft (SURC) of the United States Marine Corps was selected as the principal parent hull for the design of the Coastal Patrol Craft.

**Table 1: Key particulars of parent hull [6]**

Patrol Craft	Key Parameters and Details
Length	12 m
Beam	3.1 m
Draft	0.61 m
Displacement	9.8 LT
Max. Speed	39 kts
Cruising Speed	35 kts
Range (nm)	250> nm
Propulsion	880 hp
Power (hp)	
Complement	2 crew, 16 troops
Armament	3 mounts for heavy machine gun and smoke launchers
Planing Hull	Yes
Rigid Inflatable Collar	Foam collar
Missions	Maintain Control of rivers and inland waterways, command and control, reconnaissance, logistics/resupply, medevac, counter-drug operations, humanitarian assistance, peacekeeping, and non-combatant evacuation operations

Missions Maintain Control of rivers and inland waterways, command and control, reconnaissance, logistics/resupply, medevac, counter-drug operations, humanitarian assistance, peacekeeping, and non-combatant evacuation operations

After selecting the parent hull the key parameters such as; length, beam, draft, depth, displacement, deadrise angle, chine width, and coefficients of form were roughly determined. The comparison of ratios based on the other similar vessels and theoretical study on the planing hull design features were also considered in selecting these preliminary parameters. During the design of the hull form model using a software, (in conjunction with a plug in) some of these parameters were altered.

**Table 2: Preliminary design particulars of the Coastal Patrol Craft**

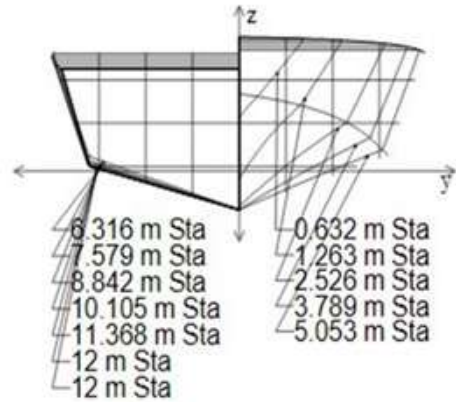
Length Overall	12 m
Beam on Deck	3.8 m
Depth	1.6 m
Displacement	8 Tonnes
Deadrise angle at transom	15
Deadrise angle at the mid body	18

After modelling the hull preliminary hydrostatic particulars, stability analysis and powering calculations were obtained based upon the parameters. As this research progresses in to more detail a comprehensive analysis for hydrostatics, stability, powering, weight, and cost estimation will be carried out. At this stage this design remains a preliminary concept design and may undergo change accordingly as the research progresses.

### III. RESULTS AND DISCUSSION

The aim of the research paper was to come up with a preliminary concept design for a Coastal Patrol Craft for the Sri Lanka Navy and the Sri Lanka Coast Guard. The preliminary design of the model was done utilizing software while another software was used as a plugin. The hull form creation was conducted based upon the similar ship analysis/ market survey and theoretical study on planing hull.

#### A. Resultant Hull Form Particulars and Hydrostatic Data



*Figure 4: Initial Body Plan*

From the initial input of preliminary design particulars mentioned in Table 2 a preliminary hull form was created and a lines drawing of the Coastal Patrol Craft was obtained. Also some other key parameters of the hull form were obtained from the software when the Coastal Patrol Craft is in displacement mode. These hydrostatics data look satisfactory and the coefficients of form were all within general limits.

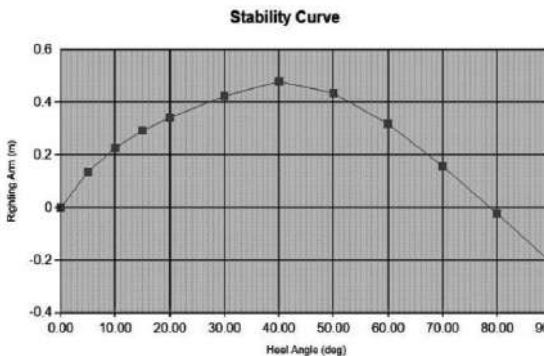
**Table 3: Resultant hull form particulars obtained from Orca 3D**

Length Overall	12.04 m
Beam Overall	3.8 m
Depth Overall	1.57 m
Waterline Length	11.25 m
Waterline Beam	3.13 m
Navigational Draft	0.64 m
LCB	6.81 m
TCB	0.0 m
VCB	-0.18 m
Wetted Surface Area	32.59 m <sup>2</sup>
Waterplane Area	29.21 m <sup>2</sup>
Block Coefficient	0.346
Prismatic Coefficient	0.743
Coefficient of Waterplane area	0.831



**B. Stability Curve**

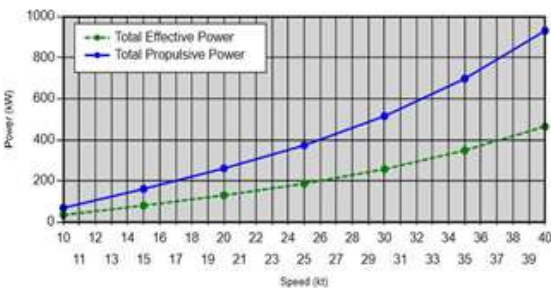
Utilizing the software a stability curve was obtained for the Coastal Patrol Craft. The righting arms of the boat was calculated for angles from 0 degrees to 90 degrees and the graph below indicates the stability of the vessel is satisfactory.



**Figure 5: Stability curve of the Coastal Patrol Craft**

**C. Resistance and Powering Calculations**

After the hydrostatics and stability analysis a resistance and powering analysis was conducted utilizing a software tool. The software uses the Savitsky method to calculate the resistance and power of the vessel. The propulsion efficiency was assumed to be a 50%, design margin was provided as 15% for the calculations. Both these values were chose as a conservative effort to gauge the performance of the hull form in extreme conditions. From these calculations total resistance at 40 knots was calculated to be 22.6 kN and the power required was calculated to be 930 kW (1265 HP) which is slightly higher than the expected value. When the propulsion efficiency is increased to a more realistic 60% the required power reduces to a 1050 HP. Below is the power vs speed curve provided by the software.



**Figure 6: Power vs Speed curve**

**D. Key Design Decisions**

During the design phase some key design decisions were made to ensure the hull form is compatible with the initial goals stated earlier. Our primary design parameter that was set aside as the uncompromising factor is the length of the patrol craft. Due to the range of missions that is expected be covered by this Coastal Patrol Craft, it was decided have a relatively large craft with a length of 12 m. Another factor that impacted this decision was the proposed mission module concept. A longer boat is the better option to accommodate these modules without cramping the deck space.

A design parameter that was based upon theoretical study rather than similar ship analysis was the deadrise angle of the boat. The deadrise angle is generally determined by the speed and the sea state that the planing vessel is intended to operate in. For coastal crafts this angle is generally between 15 to 20 degrees. The faster the vessel moves the higher the deadrise angle should get to soften the impact during slamming. Thus for the Coastal Patrol Craft the deadrise angle was selected to be 18 degrees at mid body gradually decreasing to 15 degrees at the transom. Another parameter that was selected based on theory is the placement of the LCG. According to [3], the LCG location has to be 6%  $L_p$  abaft of the center of the  $A_p$ . Where;

- $L_p$  - Chine length
- $A_p$  - Chine area

For the Coastal Patrol Craft the LCG was approximately calculated to be around 7.2 m from the origin. During the design process a value of 6.8 m was chosen as the LCG to reduce the trim. This could have also had an impact on the relatively high power requirement.

Modularity concept is one of the key design aspects that were kept in mind while designing this hull form. The length and the relatively large beam of the Coastal Patrol Craft were selected mainly to accommodate the mission modules. The modules will be fitted abaft of the centroid of the chine area (near the LCG) to make the vessel trim by the bow aiding the planing of the vessel. Also all the different mission payloads will be approximately of the same weight. The size of the mission module was determined to 1.5m x 1.5 m x 1.0 m as an initial estimation. In addition to the cost savings during the design and manufacturing phase modularity will save cost during the operational phase. During the operational phase the requirement of training

for the crew will be less because all the patrol boats will be of same class due to familiarity and experience gained. In the subsequent studies more emphasis will be laid on the design of the actual mission modules and their content based on the mission.

Some other design features that were considered during this preliminary concept design study were, adding a foam collar to the vessel and utilizing a stepped hull form. The form collar would have enhances the stability of the vessel by increasing the reserve buoyancy and the stepped hull form is known to improve planing performance at higher speeds. Both these ideas were deemed too expensive for this particular study after further research.

## IV. CONCLUSION

Since Sri Lanka is an island nation, the naval forces of the country have an immense duty and an undeniable responsibility to safeguard its waters and facilitate the commerce and communication. The key resource of any navy is their naval fleet and the capability of a nation's fleet is a huge morale booster not only for the navy but also for the commercial fleet. Sri Lanka Navy is now on the brink of becoming a fully professional navy and upgrading the naval fleet will definitely have a huge impact on realizing this goal. However as a developing country budgetary constraint will always be a hindering factor and cost effectiveness is a must in this scenario. Everybody in decision making level has to look into this project as open minded individual. Any logical suggestions to improve this patrol craft is most welcome.

This study was intended to be a feasibility study and preliminary concept design before going into full scale model. Major concerns of this study were, identifying the basic particulars, key features and role of the patrol craft. Savitsky (1964) and Halder (1966) studies and some of the software associated calculations were used as our based to determine the planing hull characteristics.

Cost saving methods such as utilizing experience curve and modularity while staying away from complex hull geometry such as stepped hull concept were considered extensively in this study. These concepts can minimize the cost for different classes of crafts, meet organizations goals and reduce familiarization and training cost, since it is indigenously undertaken with available technical support from the identified key personnel. Hence flow of knowledge within the Navy will mitigate the training cost

for this kind of a project. In addition to that designers are within the Navy, huge amount of cost saved to the Navy. One of the areas that will be addressed during the future studies are improving the hull shape to reduce drag and bring the power requirement of the vessel to less than 1000 HP for a propulsion efficiency of 50%. Also determining the actual shape, dimensions, content, and the location of the mission module will be carried out subsequently. Incorporating an inflatable collar or a foam collar will be further researched without compromising the main aim of this design of cost reduction. More analysis such as a comprehensive weight and KG study, structural analysis, cost analysis and a seakeeping analysis will also be carried out in addition to the hydrostatic, stability, resistance and power analysis.

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# WASTE ELIMINATION AND PRODUCTIVITY ENHANCEMENT FRAMEWORK FOR AVIATION MAINTENANCE MANPOWER THROUGH VALUE STREAM MAPPING

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**Abstract** - The aviation industry is booming in a rapid phase due to the exponentially increasing demand for air travel both locally and internationally. In response, the complexity of the modern aircraft too has expanded in leaps and bounds to accommodate the dynamic and the robust demand in terms of size, range and reliability. In this essence, the dependency and the concern on aircraft maintenance element cannot be over emphasised.

The aircraft maintenance process, a mandatory aspect for any airline depends on four main inputs; Maintenance Manpower, Aviation Supply- Chain, Maintenance Infrastructure and the Regulatory compliances. It is essential that these resources are to be optimally coordinated and efficiently executed to attain minimal operational costs, maximum reliability, optimal safety and fixed delivery times, which are the principal prospects of any airline to attain competitive advantage. Technical manpower is one of the most volatile and stochastic resource which determines the overall maintenance work output and therefore needs precise planning, scheduling and execution.

Unlike in other industries where human resource planning is more research based and have gone through vast developments, the aviation industry seems to be lagging behind to a certain extent due to the confined nature and the complexity of the operations which yearns more research for future progress. In view of addressing the above, this research is based on a heuristic analysis of the current aviation maintenance manpower utilization and planning patterns and tends to identify the non-value added activities and to optimally marginalize them.

Then optimal solution is derived through Value Stream Mapping technique which is a popular tool in the

operational management domain. A case study is analysed encompassing two medium size airlines to execute the above.

**Keywords** - Aircraft Maintenance Manpower, Non value added activities, Value Stream Mapping

## I. INTRODUCTION

Aircraft maintenance is a highly labour extensive process where the skill level required is relatively higher than most of the other service industries. The reliability and the quality of a maintenance task depends on the executional durability of the labour force, standards of the spare parts and consumables, operational environmental conditions and the regulatory framework. So the most unpredictable input is the labour force standards which tends to fluctuate regularly due to various reasons. Human error is a critical phenomenon which has an adverse impact on maintenance element and is very difficult to fully eliminate. Therefore a spate research area has been developed to study error induced productivity lapses which executes under the title "Aviation Human Factors". On the other hand, the optimality of the maintenance manpower planning and scheduling needs meticulous execution to attain cost benefits. The amalgamation of these two phenomena's is very rarely researched and is novel area to the aviation operational optimizations.

On contrary to the common belief, there is a vast difference between the competency and productivity where even the highly competent people would idle and be less productive due to several inductive conditions. A main lapse found in contemporary literature is that manpower is considered to be constant in terms of productive and the scheduling and

planning is executed on such grounds to attain optimality. Apart from the competency of the work force the physical and psychological aspect matters as well. The drawbacks in efficiency of each personal will eventually build up to increase the losses. Such losses contain minor stoppages, idling, speed reduction, defect and rework, motion loss, line organization loss, distribution loss, measuring and adjustment loss, energy loss, etc. The efficiency of human resource is dependent on the manpower and the number of man hours that have been spent on productive work output. Here the term productive work output is highlighted by the fact that there are two types of job indulgence observed, one being value added activities and the other being non value added activities when evaluated with the expected outcome of the specific job concerned. The portion of non-value added activities will pile up waste and in most scenarios goes unnoticed.

As discussed above this research focus on identifying the value in each of the sub activities executed by the maintenance personnel and to evaluate the environmental factors which affects either to enhance or decrease the impact. Here the factorial analysis will be on both physiological and psychological domain to uncover the proportional influence. The environments concerned will also be both organizational and personal. The main attention would be paid upon analysing effect of manpower reduction due to personal factors due to working environmental, physical and psychological issues.

## II. RESEARCH PROBLEM

Identify the non-value added activities which affect the aircraft maintenance manpower productivity and to formulate a heuristic framework to optimally marginalize those non value added activities.

## III. RESEARCH OBJECTIVES

1. Differentiating the maintenance activities in terms of value addition to the expected outcome.
2. Evaluate the environmental factors which affects the above.
3. Evaluate and identify the organizational factors which affect the value addition.
4. Formulation of a waste optimization heuristic framework through value steam mapping.

## IV. LITERATURE REVIEW

Since there are uncountable number of facts from smaller to larger which affect to the future of an organization, human resources hold a major position above all. When people work as sets of individuals or individuals in an organization to achieve the given tasks, they are responsible for the final outcome of their efforts and as well as the expected goals and the objectives of the organization.

Since the future decisions of an organization take it to the top of the world, involvement of the behaviour or the acts of each and every individual in the organization is highly essential because either it is a smaller or larger organization, manpower of that organization can change the whole environment of future decisions. To maintain the organization as a well performed one, the board of management of it has to plan the manpower they have well.

When the future of the organization depends on the manpower it has, the top management has to get the decision that who are the most capable people to fulfil the given task in a given area and how many people have to take part of it because the productivity of the organization which directly affects to the future of the organization entirely depends on the decision of the top to lower management of that organization. Because of this, selection of the right worker for the right work in a specific area must become an objective of planning of manpower. Any organization could not survive with only materials, equipment, plans, labours, management and other resources. It is a true fact that any company needs the involvement of all the above mentioned parties to survive



Figure1. Labour Productivity Improvement

in the world. But even though it has all the things above, if the management could not handle or plan how the labours work, who is suitable for the particular job all the things become useless.

According to the Management Study Guide, it is known as the manpower planning or the human resource planning. It shows that the planning of human resources in an organization is essential for the future of it. Human resource planning helps to implement the managerial functions like planning, controlling, organizing, directing and staffing becomes the key for them. Also it motivates the workers, increase effective management of personnel and increases the inter relationship of working people. But the most important fact that due to human resource planning, the productivity of the organization will be increased. Or in the simple meaning, management must know how to get the highest productivity in an effective manner by using the manpower they have since it is a result of minimum usage of time, money and energy of individuals in the organization.

According to TechTarget, human manpower productivity in an organization is known as the total efficiency of the sets of individuals or the personnel who works to achieve the expected goal and objectives of it. The general meaning of the manpower productivity is the ratio between outputs to the input of a given worker in a specific time period with respect to a set of workers who are doing the same work in same given time.

Refer to the article by Vicki Bell in 2006, she says that according to the two authors from the Institute of Engineering at the National University of Mexico who are known as Eugenio López –Ortega and Rita Saloma-Velazquez, there are so many external facts in a company which are a bother to the workers' daily routine. These two authors categorized the factors which are influenced for the productivity of workers in to four groups as Personal factors, work team factors, technology factors and organizational factors.

When talking about the factors effecting to the worker's day today routing, personal factors takes priority among all other factors. Because no matter how much any other factors are well organized, one little personal factor of an employee can ruin the whole production line. These things depend on person to person because people have different personalities and due to that they must have different personal matters which will affect the future

of the organization. Personal factors which are affecting to the daily schedule of worker can be his responsibility, educational level, personal hygiene, satisfaction...etc.

As mentioned above, every worker has their own responsibility to the work they have done during the production process. All the peoples' commitment must be there to fulfil the expected outcomes of the company. Everyone has and chosen for a specific duty to fulfil. But if someone is trying to do a work which does not belong to him/her it can be a great loss for the profit of the company as well as the worker's wealth. If the person who is going to do the given specific task does not have enough educational qualifications for that job, he cannot take the responsibility of it. So for the future of the company, the management has to bring the right person with enough capability to achieve the goal.

And personal hygiene matters of the employees are also essential and they must take care to have a well performed company. Every person has these types of problems in day today life. But when it goes to a company, top management has to give a solution in general for these matters. They can build necessary places near to the working places, they can schedule enough time to do changing of clothes, having meals...etc. By giving gifts, bonus, compliments and also motivation to find new technologies to do the work, the company can satisfy their employees.

In a company, everyone has to work as a team and there must be a leader to guide them; not a boss. With a good leadership, employee has a satisfying working environment with them because good leader is a person with creativity, confidence, straight forward, quick decision making and communication skills as the University of Notre Dame says. A good leader can take the organization from lower level to top level because he knows how to communicate with group of different people with different minds. Even though it is much hard to deal with a bunch of different people, a good leader can handle all these things with visions and goals.

Leader should be a good listener and a person with attitude. Because to the employees, he should be a trustworthy person to discuss their matters. That helps to relax the employees mind and because of that they can focus on what they have to do without any stress. Then they can give their maximum output to their working place.

Also to get a maximum output from the employees, company should give them a good training at the correct time. And also the company should be capable of providing a good working environment with good instrumentation, ventilation, safety and comfort to the people who are working for a long time period to achieve targets.

From all the above factors which are affected to the daily routing of employees, the final result is that customer gets a defected production in their hands. Because when the person who creates the final product has to face all the disturbances during production, he does not focus in building a perfect production according to customer satisfaction and he does not give his maximum effort for that. So even though the management expect 100% outcome from the employee during production, it is always in the minimum level of below 50%. This will head up company in a great danger because customers lose their trust upon the company due to late defected final products. When the customer loses their trust about the product, they do not have any interest to buy it. This situation is directly affect to the wealth of the company and it brings the company from top level to lower level in the current business world. And also productivity is known as being organized. When a company is being more organized, the productivity of the company also increased. It is because when everything is placed in the correct place, worker does not need to spend his time to go everywhere to find them.

When there is a well-organized schedule and planning of noted down the work, during the shift changes next person does not need to start from the beginning that looking for what have been done by first person and from where he has to conduct the rest. It saves much time for complete the work of the person.

So the productivity is much more important in a workplace to take the company or the organization to the top of the current business world.

## V. METHODOLOGY

In order to acquire the required data to build a critical analysis on manpower optimization the research data collection and analysis is carried out in two phases.

### A) Secondary data collection

The first phase in data collection will be going through literature and building up a critical analysis between

expert views and build up the relationships. In this phase understanding the formulations and functions for man power calculation will be done. The expanded understanding will be helpful in discussing the optimization plan.

### B) Primary data collection

At this stage a questionnaire will be distributed. In order to collect data in a global scale the questionnaires will be distributed among employees of aircraft maintenance facility of,

- Emirates Airlines
- Etihad Airlines

As these are global businesses the identity of each individual will be kept confidential and the data will be collected in a general mean as such, without individual comparison of company but taking all feedbacks as a whole.

In order to achieve this a viable sample will be selected that can be validated in giving a general conclusion.

With analysing the collected data and with the use of formulas and implementation of data the final output will be provided.

### Value stream mapping

Value stream mapping is a lean-management method for analysing the current state and designing a future state for the series of events that take a product or service from its beginning through to the customer. The collected data would be utilized to assess the current state and an improved future state will be formulated through further analysis and expert opinions.

### Sample size and the demographical restrictions

The sample selection is done to acquire less cost, less field time, improve accuracy and when it is impossible to study as a whole. As this research is delivered in a global scale a larger sample is required to achieve the most accurate outcomes with the size of the total population. From the two basic methods,

- Non-probability sampling
- Probability sampling

The Probability sampling method can be convenient as per the population's each subject has a known probability

of being selected. This allows application of statistical sampling theory to result in generalise and test hypothesis. The basic demographic concerns are on the type of aviation personal taken into population selection. From all the aviation aspects the first sub category taken as maintenance personal and second sub category and selected sample is built under engineering personals and technicians thus the population is given a representative chance of gaining a probability.

## VI. RESULTS AND DISCUSSION

The questionnaires which are distributed focus among the given areas of data, which will be used for calculation of total manpower availability and the available productivity in the present. A more optimized mean of improvement in productivity will be looked forward in providing with this research. As the expected complete sample size is placed in a higher number the basic discussion is carried out with the available data as a sub part of the exact sample. With these data the non-value added activities are highly focused on improving to build up a greater productivity level. In accordance with the collected number of feedbacks (40) the following arguments can be made;

8. What is the average meal time for?

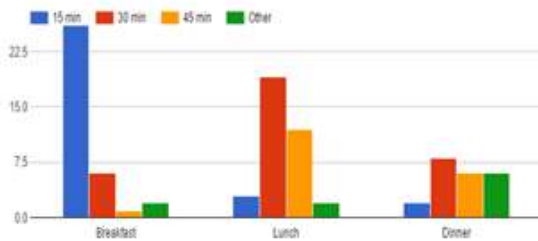


Figure2. Average Meal Time

This time can be consumed for value added tasks if the workforce can satisfy the requirement in a specific time frame. That can be a mean value of the general requirement.

9. Time taken for personal hygiene (38 responses)

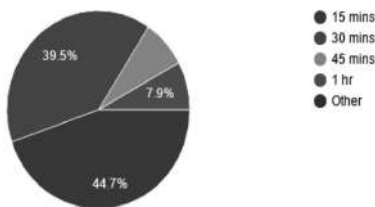


Figure3. Personal Hygiene

As for the personal hygiene needs, that cannot be restricted haphazardly. As the health factors are considered in selection of workforce an unusual hygiene behaviour spent irresponsibly can be directed towards proper management by which the spare time can be added for other value added tasks.

10. Average briefing time (37 responses)

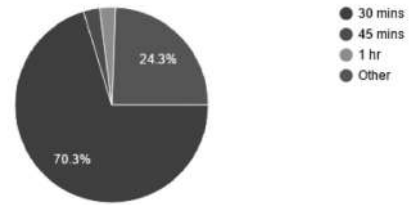


Figure4. Briefing Time

Average briefing time can be given as the most common time space given for a number of tasks. When a large sample is considered this number may increase up to an apparently large number and drawback.

11. Time spend for walking/travelling to other places from work place (Ex: - Tool bay, Inventory, Workshop) (35 responses)

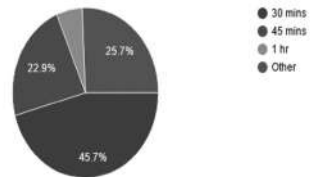


Figure5. Travelling Time

Travelling from one place to another even for unavoidable reasons build a lag in the productive time. This need to be avoided by the most effective placement of required places and tools.



12. Total time waiting for instructions (36 responses)

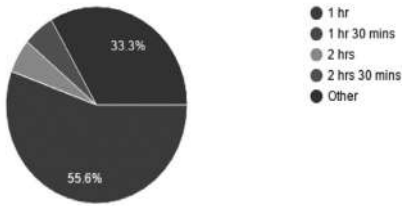


Figure6. Waiting Time

Employing that time for value added activities may bring up more productivity to the plant. Proper communication is always essential as each task will affect one another.

13. Time spend for safety drills (34 responses)

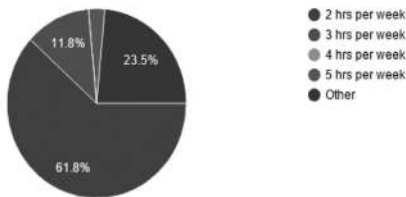


Figure7. Safety Drill Time

Safety is a main concern from individual up to a legal aspect. The greater the safety the more the confidence is built. Though this is a concern it need to be properly managed without effecting the other scheduled work that are being carried out.

14. Time to process a work order (34 responses)

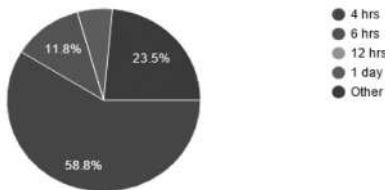


Figure8. Work order Process Time

The procurement process of inducting the required items, components, material, etc. is a major task that consume more time and lag in task completion due to the lack of inventory management.

15. Time taken for shift changes (36 responses)

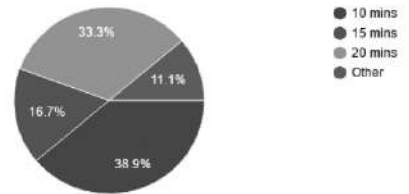


Figure9. Shift Changeover Time

All maintenance tasks are mainly shift based work. The changing of shifts should be well managed thus it will not spare more time without an employee to take over the work as soon as possible without any glitches on what need to be done.

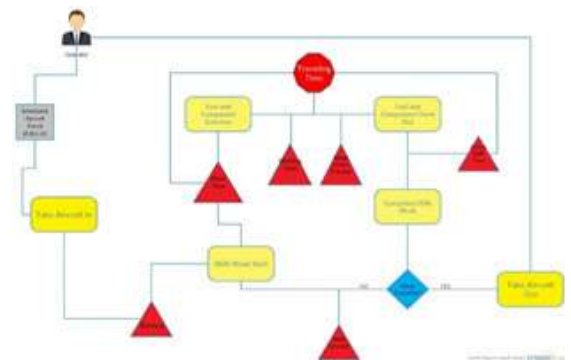


Figure10. Current state Value Stream Map

## VII. CONCLUSION

The conclusion is built up with the aid of value stream mapping methods. Using the current Value Stream Map, the organization can identify their current state, and next future state which can directly affect to the future of the organization. The lean thinkers can improve the performances of the production with the customer satisfaction after implementing the Value Stream Mapping process. With this the second phase will provide a streamlined process to minimize these areas that were identified.

With this the non-value added activities may be omitted or mitigated up to a minimum. In this way understanding and clear identification of value added activities and non-value added activities of an organization become easier.

In this research the analytical path is built up toward the basic needs of employees, whether it bring up unnecessary waste of productive time. With the available feedback it provide the likelihood of these activities to optimize the productivity.

According to the findings each highlighted area is prone to build up a lag in optimum productivity. As per the findings,

- Meal Time
- Personal Hygiene
- Briefing Time
- Travelling Time
- Waiting Time
- Safety Drill Time
- Work order Process Time
- Shift Changeover Time

Can be activities that bring down the productive time. These areas can be promoted in building a proper mean of improved work environment. Also can be named as Non-value added activities. With the completed study a better understanding and presenting of the non-value added activities from value added activities whilst reaching the prime objective of this research to bring up the optimum manpower planning method with the highest productivity level in hand will be provided.

### VIII. FUTURE WORK

As the process flow have taken place with respect to the feedbacks under the demographic factor of Srilankan employees the study will be carried out by developing a greater sample size with a complex combination of individuals.

This will be followed as phase II and a future probable VSM will be developed by overseeing the available waste areas in a broader state.

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# 3D ANTHROPOMETRIC SCANNING BASED ON PATTERN PROJECTION

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**Abstract** – In the current global fashion marketplace taking body measurements using scanner technologies is increasingly gaining popularity. This is mainly due to the majority of transactions are now being done online and almost 50% of such purchases are returned annually due to mismatches in size. The time and effort requirement for taking manual measurements is also a contributing factor. Several studies have been carried out in this regard, particularly in the Bio Medical field where anthropometry is an integral part in diagnostics. Several companies are also providing 3D scanning solutions for the fashion industry with various attributes. However the majority of such scanners are based on Laser Triangulation System which is not the most economical in a competitive environment. This study focuses on the feasibility of incorporating a scanner based on pattern projection for the same purpose. The main aspects this study will be covering are achieving a low scanning time and a significant reduction in cost against the conventional method. The Laser Triangulation Scanners that are currently in the market take up to 33 seconds in scanning time while ranging between \$25 000 - \$85 000 in cost. This study will discuss the possibilities of achieving a scanning time under 5 seconds and designing the physical scanner under \$10 000.

In the Pattern Technique, a series of stripes/patterns were projected simultaneously on to the object. This contrasts with the Laser technique where scanning is done on a single line of point where independent range profiles are processed. Patterns ranging from simple stripes of white light to complex Moiré patterns were tested out on a Mannequin with a standard erect pose. A camera was used to view the projected pattern from an angle complimenting the projection angle which generated straight equally spaced fringes incident on the surface, producing equally spaced contour intervals.

The study indicated that using Moiré pattern projection wasn't the optimal solution in body scanning, given the constraints. The complex mathematics involved in demodulating the viewed pattern to create fringes required extensive processing. Binary coded pattern was generating the best results as it required a simple low cost projector and simple processing. However the use of incoherent light resulted in a compromise of the depth of view and the resolution of the image compared with its laser technique counterparts, a drawback which can be mitigated during programming.

**Keywords** - Anthropometry, Triangulation, Pattern Projection, Structured Light

## I. INTRODUCTION

Today, with the advancements of technology, fashion industry has taken many forward leaps where it is no longer necessary to step in to a tailors shop or a clothing store to browse for clothes. The trends are changing day by day and there are a myriad of options to choose from. Online stores such as eBay, Amazon, Shopify and Tobi are increasingly gaining popularity while many others are popping up in the Internet. Garment manufacturers and Retailers are connected with a global marketplace with an ever increasing demand for their products. But one of the major challenges encountered in this global fashion market place is the lack of a standard procedure to get the dimensions correct. It is estimated that almost 50% of all the online clothing purchases are returned back to the sellers due to mismatches in size.

Anthropometrics, simply known as taking body dimensions has taken a novel approach in order to meet the demands of the expanding fashion industry. Body

Scanning has been cited as the go to solution in this regard. While body scanning has been prevalent in the Medical Field for several years, it is a relatively novel subject in the context of fashion. The industry demands for a highly efficient, low cost device with a relatively simple setup.

However most of the current solutions in the market have fallen short of addressing the key requirements of the industry although they might be incorporating very sophisticated technologies. Almost all the existing solutions fall under the price range of \$25 000 - \$85 000 which seems obsolete in the perspective of Small and Medium scale fashion designers and retailers. Moreover the space requirement of around 50-100 sqft and the long scanning time haven't been addressed by most of the developers.

Due to the above mentioned predicaments the fashion industry is yet to embrace body scanning with both hands. It is still confined to a few high end apparel designers and manufacturers many of whom went back to the conventional method of manual body measurement citing the complex operation of scanners as extra effort. It is a fact that the global fashion industry's major players are small and medium scale designers who operate under limited budget and restricted spaces. Therefore body scanning technology is still out of league for the majority involved in the fashion business.

Emerging markets especially in countries such as Sri Lanka, Bangladesh, Kenya and Vietnam could see long term growth in their operations and increase

their competitiveness in the global market if this technology was within assess for them. Hence this study is an attempt to discuss the viability of pattern projection techniques in scanners used for body measurement.

## II. METHODOLOGY/ EXPERIMENTAL DESIGN

The approach for the development of the prototype was based on several key steps;

- 1) Determining the Fringe Projection Technique
- 2) Development of a Mathematical model for Phase Evaluation of the Projection
- 3) Simulation on basic 3D shapes
- 4) Simulation on a Mannequin
- 5) Calibration and code modifications

Preceding the Prototyping phase, developing a working model for live samples is currently under way. There the complexities that arise due to clothing, minor body movements and other variables have to be accounted for during coding and calibration, which will not be discussed in this paper.

### a) Determining the Fringe Projection Technique

The principle used in developing the scanner is measuring the three dimensional shape of an object using projected patterns of light on the surface of the object. Projecting narrow stripes (binary coded) of lines on to a three dimensionally shaped surface produces a distorted array of form when it is viewed from different perspectives than that of the projector. This form can be used to generate an exact replication of the surface's geometric shape.

With two main methods of stripe pattern generation available; laser inference and projection, the latter was selected for the purpose of this study considering the cost and complexity of implementing the laser inference method. Projection of incoherent light involved selecting a spatial light modulator for the projector, which were available in several different technologies. The following table discusses the characteristics and applicability of three such methods namely; Transmissive Liquid Crystal, Reflective Liquid Crystal on Silicon (LCOS) and Digital Light Processing (DLP).

**Table 1: Spatial Light Modulator Technologies**

Feature	Liquid Crystal	Liquid Crystal on Silicon	Digital Light Projection
Contrast Ratio	Good	Best	Worst
Light Output (Brightness)	Good	Worst	Best
Color Accuracy	Good	Good	Good
Motion Blur	Worst	Worst	Best

Out of these technologies which suited mostly with the study requirement was Digital Light Projection (DLP), since the main objective was to achieve a higher brightness for the light pattern rather than a higher contrast. Moreover the pixel boundaries that appear due to the lower contrast can be negated due to the superior motion blur of DLPs.

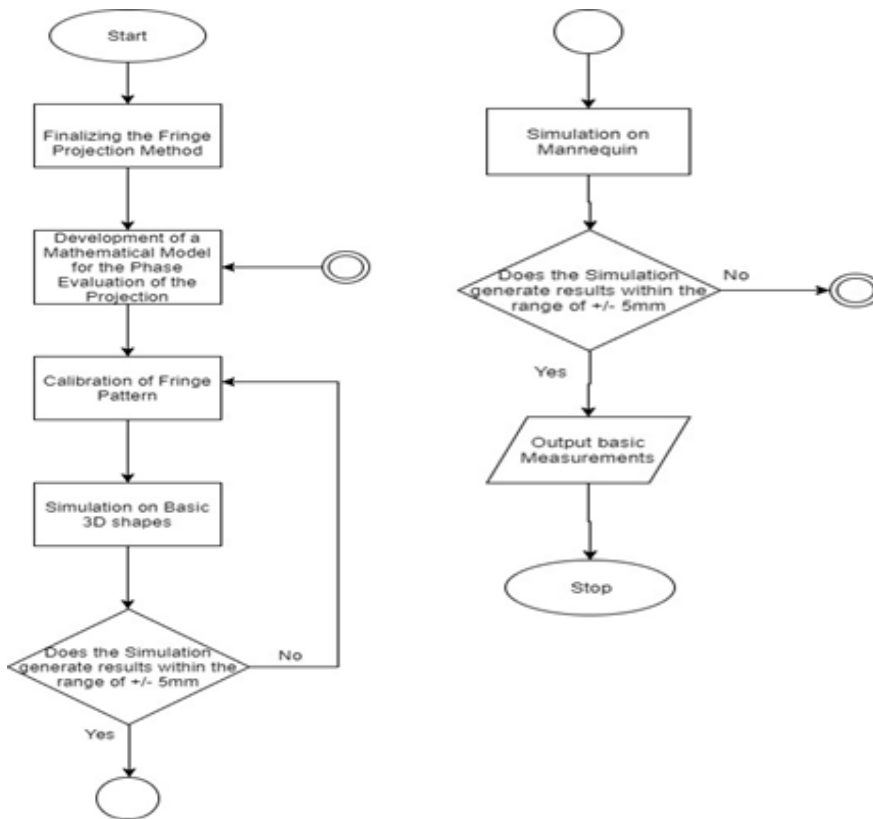


Figure 1: Prototyping Process Flowchart

The DLP used in this study was a low cost general purpose projector obtained from a local camera equipment shop. It was then disassembled and the in built spatial light modulator was replaced with a custom build one. This module was used to project the fringe pattern on to the Mannequin. See Figure 1.

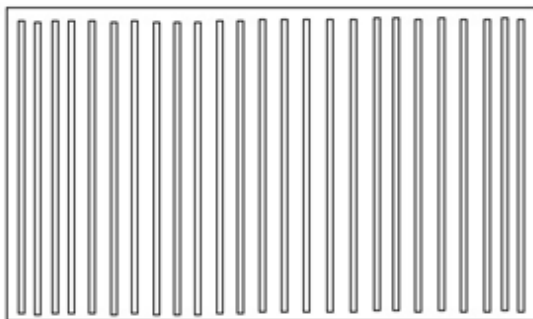


Figure 2: Spatial Light Modulator with Fringe Pattern

**b) Camera and Projector Calibration**

Although the camera used in the initial phases of the research was a DSLR, it proved to be ill suited for this application due to a variety of different reasons. The main reason being the overheating issues of the sensor when remaining in operation for substantial periods of time.

Moreover the imagery generated by the camera used was not a supported format by the MATLAB Image Acquisition Toolbox. Since MATLAB was used as the main tool in demodulating the images, it proved to be convenient to use a compatible device. According to MathWorks, following are the supported devices by the Image Acquisition Toolbox;

- Scientific video cameras
- USB and FireWire (IEEE-1394, i.LINK) Web cameras
- Video capture boards
- DV camcorders

It has also provided a list of Manufacturers as a guideline and it was incorporated in the process of narrowing down

the options under criteria such as Image Quality, Cost and Interface. For the purpose of this study Point Grey Grasshopper GS3-U3-14S5M-C was used, which provided a rate of 30 fps.

As a standard practice, camera calibration required recording a sequence of Images of a calibration object, essentially a simple 3D shape, comprised of a unique set of distinguishable features with known 3D displacements. Thus, each image of the calibration object provides a set of 2D to 3D correspondences, mapping image coordinates to field points.

Projector calibration is also a paramount factor when perusing to achieve a high quality scan. It is supplemented by the fact that implementing lower cost digital projectors could essentially compromise the quality. The projector is ideally the “inverse” of a camera, wherein points on an image plane are mapped to outgoing light rays passing through the centre of projection.

### c) Developing a Mathematical Model for the Phase Evaluation of the Projection

The observed stripe patterns on the surface contain several depth cues. The displacement of an individual stripe can be converted to three dimensional coordinates. For the identification of individual stripes, a stripe counting technique was incorporated. These fringe patterns were then used to reconstruct the 3d shape of the mannequin.

The algorithms used to decode the structured light sequences are relatively straightforward with a reasonable level of literature availability.

For the camera, it required to be inferred whether a given pixel is directly illuminated by the projector in each displayed image. If it is illuminated in any given frame, then the corresponding code bit was set as high, otherwise it was set to be low. The decimal integer index of the corresponding projector column was then recovered by decoding the received bit sequences for each camera pixel. A manually selected intensity threshold was incorporated to determine whether a given pixel is illuminated.

The following Pseudocode proposed by Douglas Lanman and Gabriel Taubin was used as the basis for developing the demodulating program used in this research.

#### **BIN2GRAY(B)**

```
1 n ← length[B]
2 G[1] ← B[1]
3 for i ← 2 to n
4 do G[i] ← B[i - 1] xor B[i]
5 return G
```

#### **GRAY2BIN(G)**

```
1 n ← length[G]
2 B[1] ← G[1]
3 for i ← 2 to n
4 do B[i] ← B[i - 1] xor G[i]
5 return B
```

## III. RESULTS AND DISCUSSION

The demodulated 3d structure was harbouring an error of 1.4cm after calibration. This condition was due to a resolution drop in the fringe projection which was later overcome by applying new spatial light modulators with reduced stripe width and conditioning the backlight. But further decreasing the width of the stripes gave inconsistent results, which was partly due to the limited depth of field of the camera that was used and the poor optical quality of the stripes.

Given the inconsistencies, the generated three dimensional structure was an improvement over the image generated by a standard Kinect sensor. The resolution was higher and the form was smoother. However, it wasn't adequate for the expected level of accuracy for the measurements. Apart from opting for a better camera with a higher depth of field, it was decided to use phase shifted projections.

Alternating stripes were projected on to the surface while 3 to 8 exposures were taken each with a slightly shifted phase. This approach proved to be more effective in resolving the surface errors of the image. It also allowed the image resolution to increase approximately up to 1/10 the of the stripe width which was initially set to 3mm.

The outcome could be further enhanced if Grey-Code binary images were used in the process. Binary grey code sequences identify the number of each individual stripe hitting the object. This is the same principle used in some position encoders and can be readily implemented for optical encoding.

Several other measures that could be embodied to obtain further enhanced results are using stripe frequency and phase in a Fourier Transform and using Wavelet

Transform techniques. A combination of these methods could achieve an escalation in the resolution up to 1/50 the stripe width. However, the defocus of the projected pattern cannot be addressed by any of these measures. It is a phenomenon that arises due to the requirement to use a large projector lens in order to cover the entire body surface of an average person.

Improvements done in the Image sensing segment (i.e.: camera) is an integral part in enhancing the quality of the 3d image. Here in the study, the camera used was a standard DSLR camera positioned 45° to the line of projection. But in ideal conditions at least two cameras positioned at complimenting angles should be used. This method also known as stereoscopic vision requires more complex programming which was one reason for excluding it in this particular study. However combining it with “structure from motion” techniques, the visual accuracy of the image can be vastly improved.

The size of the CMOS sensor is also a contributing factor for the quality of the 3d image. The camera used in the study comprised a sensor with APS size range (14mm by 21mm to 16mm by 24mm). Using a camera with a full frame sensor (i.e.; allowing for the use of the lens without the complication of focal length magnification factors) can generate the highest quality images.

## IV. CONCLUSION

Pattern Projection in 3d Anthropometry is not a widely discussed concept when it comes to body scanning technologies. This is partly due to the widespread use of

Laser Triangulation systems and the rise of IR scanners such as the Microsoft Kinect and ASUS Xiton. However the currently available scanning solutions used for the purpose of taking body measurements haven't been successful in reaching the wide spectrum of the fashion industry. The exorbitant cost of the setup, restricted maneuverability and the unimpressive scanning times can be identified as the cause.

The structured light pattern projection method presented in this study has addressed some of those pressing issues with impressive results. Especially the cost can be reduced by more than tenfold of the existing solutions. Moreover the minimal setup is easy to maneuver and requires less floor space. However there are several issues to be addressed before the system being commercialized. The constrains in achieving superior resolutions compared to its Laser triangulation counterparts is a major drawback of this system. Moreover, the pattern blur is an inherent undesirable to this system which had to be tolerated at this level.

Taking the overall understanding in to perspective, it can be established that Pattern Projection techniques in 3d Anthropometry is an apt solution for the fashion industry. Most drawbacks encountered in this study can be mitigated with superior processing and device upgrades still maintaining the cost threshold.

Therefore it is strongly recommended that new light be shed on the subject in order to come up with a system that will replace manual body measuring with 3d anthropometry.



# SMART CANE FOR STAIRCASE AND WATER DETECTION

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**Abstract** - The World Health Organization (WHO) reported that there are 285 million visually-impaired people worldwide. Among these individuals, there are 39 million who are totally blind. Blind people need some help in interacting with the society. Existing devices are able to detect and recognize objects that emerge on the floor, but a considerable risk is also included when the objects that are at a sudden depth, or obstacles above waist level or stairs. The designed smart cane uses a single IR sensor to detect staircases and a water detection sensor is used to detect water pits. If there's a staircase or a water pit, user will receive an alert as a form of audio voice output informing him whether the path is clear for him to safely walk forward. This project aims at the design and implementation of a detachable unit which is robust, low cost and user friendly, thus, trying to aggrandize the functionality of the existing white cane, to concede staircase and water pit detection. The smart cane was tested for its proper functioning while operating successfully in detecting staircases and water pits.

**Keywords** - IR sensor, staircase, cost effective

## I. INTRODUCTION

According to the statistics of World Health Organization(WHO), 285 million people are visually-impaired. 39 million are blind and 246 have low vision. Even for the non-visually impaired the congestion of obstacles is sometimes problematic, it's even worse for the visually impaired. People with visual disabilities are often dependent on external assistance. Humans, trained dogs, or special electronic devices can be taken as support systems for visually-impaired people. Majority of visually impaired people cannot find their way autonomously in an unknown area. Generally visionless persons use a white cane or walking cane. It is a pure mechanical

device dedicated to detect static obstacles on the ground, holes, uneven surfaces, steps and other hazards via simple tactile-force feedback.

Its light weightiness and the capability to be folded into a small piece can be advantageous to carry around when not required (Fig. 1). These simply designed canes are only capable of detecting below waistline obstacles like street curves and simple guidance between distances. Even though these canes are capable of detecting obstacles, receiving feedback is very low (Sakhardande et al., 2012). Therefore, visually impaired individuals still find it difficult to navigate especially in unknown environments. More high-tech devices, using different types of range finders, have been in the market and have been widely used too but they are discarded on the basis of cost and other factors.



*Figure 1. White cane/walking cane*

Despite various research findings to improve the mobility of the blind, there are drawbacks in the existing solutions. The major disadvantages of these solutions are:

- 1) They only detect obstacle existence and distance without specifying indication about their nature which is important for the user to know.
- 2) They are unable or inaccurate in detecting some obstructions that are not protruding but present potential threat such as descending stairs, holes, etc.
- 3) The system communicates its recommendations, through intensity or frequency variations. Thus, feedback information is often sent to the user through vibration. So, a training course is needed to keep the user informed about how to understand and react in real time to alerts that are transmitted regarding the existence of obstacles as well as their recognition. On the one hand, such training can be sometimes more expensive than the product itself.

To overcome these difficulties, cost effective white cane has been designed to detect nearby stairs, water pits and alert the user about these using audio signals. This white cane is designed to guide visually impaired people when they are moving without his/her guardian. Structure of this product can be divided into three main parts as Smart cane, Detection module, IOT module and mobile app. Each part has its own inputs and a process to provide the output. This system includes four features namely staircase and water detection, IoT Module, navigation, emergency alert which provides essential aids to the visually impaired person.

## II. LITERATURE REVIEW

### A. Early Developments

In 1958 Kenneth Jernigan, the director of the then Iowa Commission for the Blind, now known as the Iowa Department for the Blind introduced the Iowa Cane. This was made from fiberglass which improved the sound produced by the cane when it was tapped on a surface. Its handle was of green plastic with a metal tip at the bottom of the cane. With time the white cane has gone through various developments which have most of the time prioritized the ease of usage. For storing purpose the telescoping and folding canes were introduced (Strong,2017) With the time, white cane has gone through many technological advancements and has ultimately reached the level of a smart cane which not only can serve as a

mobility support but also as an obstacle detection device may it be above the knee level (Sheth et al., 2010) or below the knee level (Azigi and Hurst, 2011).

### B. Recent Advancements

For the detection of the obstacles, sensors such as IR and Ultrasonic sensors (Sheth et al., 2010) have been widely used. Informing the blind of the detected obstacles has been done using methods such as vibrating the stick and sending a voice output (Sheth et al., 2010).

Detections for the stair cases, Ultra Sonic sensors have been used in some researches (Bouhamed et al., 2010; De Alwis,2016). A pair of infrared sensors has been used to detect stair-cases and other obstacles presence in the user path, within a range of two meters (Nada,2015).

Some researches has been using Kinet sensor and 3D image processing in indoor scenarios in different lighting conditions and the results showed it can identify walls, doors, stairs, and a residual class that covers loose obstacles on the floor accurately (Pham et al.,2016).

Water sensors have used to detect puddles, water pits and water spreads (Nada et al.,2015).

For the IoT equipped smart cane we have used the IR sensor technology to detect obstacles, stair cases and the water sensor to detect puddles, water pits as the project name suggests IoT technology, MIT App Inventor to build the code and google maps for navigation purposes. IR sensor technology uses infrared waves (near IR region) for object detection. The first practical IR detector sensitive to IR wavelengths up to 3m employed lead sulphide (PbS) as the IR sensitive material. During the last four decades, different types of detectors have been combined with electronic readouts to form detector focal plane arrays (FPA) revolutionizing the field of infrared imaging. Progress in integrated circuit design and fabrication techniques too have contributed to the rapid growth and performance of these solid-state devices (Rogalksi,2012).

## III. METHODOLOGY AND EXPERIMENTAL DESIGN

### A. Data Gathering

Qualitative and quantitative data required for designing the requirement specification for the IoT equipped smart

cane was gathered through interviews, questionnaires and document review techniques which were carried out at the Ceylon School for Deaf and Blind. Face to face interviews were conducted with the Principal of the Deaf and Blind school, teachers and students. Questionnaires were distributed among students and teachers' and answers were gathered accordingly.

## B. Data Analysis

The data which were gathered during the data gathering phase were analysed by using various analysing techniques. Through analysing the data, the group could reveal the extent procedure, problems, limitations, suggestions of the students and teachers for the smart cane. Drawbacks in the existing solutions are the lack of ability to use traffic signals and to get real time updates of the surroundings of a specific location, lack of information provided to the visually impaired people to get details about public transport, lack of ability to cross the road safely without getting disturbed by obstacles laying around the road, lack of ability to get to know about puddles, lack of ability to use staircases. Concluding the analysis section, the authors finally decided to design an IoT equipped smart cane with the ability to alleviate all the above- mentioned drawbacks.

## C. Approach

The users of this system are visually impaired people who need to navigate between places for various tasks for their daily needs. There are five main inputs such as pairing request by the mobile app to the smart cane, pairing request by the mobile app to the IoT module, data collected by the smart cane and IoT module to the mobile app, triggering a navigation voice input "navigation" should be given and send an emergency message with the location voice input "help". The readings are sent to the mobile app of the smart cane using the IR sensors and water sensor, giving audio feedback to the user about the sensor data and traffic light data by the mobile app. With the voice input "navigation" Google maps opens and with the voice input "help" emergency message is sent to the guardian.

## D. Technology Adopted

Four important state of the art technologies were used in developing the IoT equipped smart cane. Arduino open source hardware/software platform was used to make the prototyping phase faster. In developing the hardware part an Arduino UNO and Arduino Mega2560 were used. Arduino IDE was used to program the hardware parts. In order to develop the Mobile application MIT App

Inventor was used (Fig. 2). It is an open source, web-based system developed by Google that allows people to create android apps for prototyping purpose.

IoT is a novel concept used in order to incorporate with the smart cane for better functionality and it is the key feature in this solution. IoT modules are installed in smart cities and certain specific places and the smart cane is designed in such a way as to enable communication with such installed IoT modules.

Three IR sensors were used in this cane. They are placed in order to detect barriers to the right, left and at the center of the user. When an obstacle is detected by any of these sensors, instructions are given to the user by a voice output alerting the user to avoid the barrier ahead. He will also receive updates about the barrier when it is too close to him.

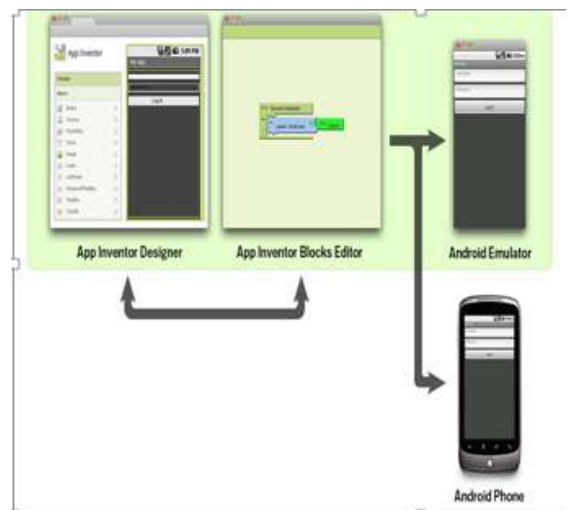


Figure 2. Use of App Inventor with Android phones

## E. Hardware Design

1) Design of the smart cane: The smart cane basically carries out two functions. They are detecting barriers ahead of the user and transmitting the relevant data to the android application. In order to execute these functions the following items were used.

- Arduino UNO
- Breadboard
- HC-06 Bluetooth Module
- 5 IR Sensors – (GP2Y0A21YK0F)

- Arduino Water Sensor
- Toggle
- Switch
- 1 LED (On/Off State Indicator)
- 9V battery
- Jumper Wires
- Project Box

HC-06 Bluetooth module is paired with the android mobile phone which transmits the data gathered through the sensors to the android mobile phone.

Three IR sensors are used to detect any barrier or obstacle and send that information to the Arduino software platform. Two other IR sensors are used in order to detect steps (staircases) or puddles on the ground. Water sensor is used in order to detect puddles by the way.

Toggle switch is used to turn the circuit On/Off and an LED is used to display the On/Off status in the circuit. A 9V battery supplies power to all the electronic items in the smart cane and a project box is used to house all the components. Jumper wires are used to interconnect the components. (Fig.3)

UNO board is powered by a 9V battery which is connected to the DC (direct current) input terminal of the Arduino UNO board.

The bread board is given a +5V by connecting its positive power rail to the +5V pin in the Arduino UNO board (shown by the black wire connecting the bread board and the Arduino UNO board). The black wire connects the GND (ground) pin of the Arduino UNO board to the bread board.

**Each IR sensor has three main outputs:**

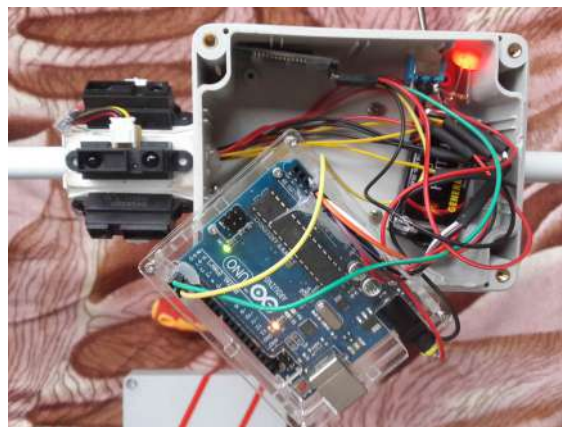
- VCC, the positive voltage terminal (indicated in red) is given a +5V by connecting it to the +5V power rail in the bread board.
- GND, the negative terminal (indicated in black) is grounded by connecting it to the negative power rail of the bread board.
- Analog terminals of the three IR sensors (indicated in yellow) are connected to the A0, A1 and A2 Analog input pins of the Arduino UNO board. These Analog terminals transmit sensor data collected by the IR sensor to the Arduino UNO board.

**The Bluetooth module HC-06 has four main outputs:**

- VCC, the positive voltage terminal (indicated in red) is given a +5V by connecting it to the +5V power rail in the bread board.
- GND, the negative terminal (indicated in black) is grounded by connecting it to the negative power rail of the bread board.
- TX, the transmitter of the Bluetooth module (indicated in orange) is connected to the RX, the receiver of the Arduino UNO board.
- RX, receiver of the Bluetooth module (indicated in green) is connected to the TX, transmitter of the Arduino UNO board.

**Water sensor has 3 main outputs :**

- VCC, the positive voltage terminal (indicated in red) is given a +5V by connecting it to the +5V power rail in the bread board.
- GND, the negative terminal (indicated in black) is grounded by connecting it to the negative power rail of the bread board.
- Signal, this terminal is used to send the analog data in regard to the water level.



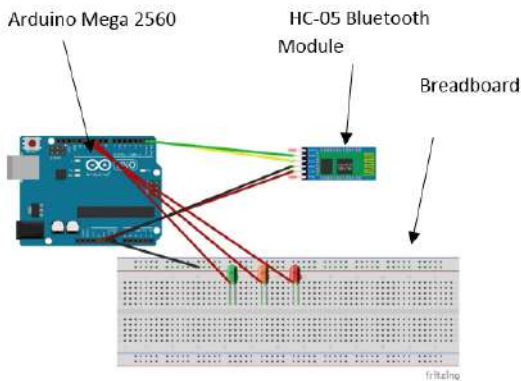
**Figure 3. Hardware Design**

2) Design of the IOT module: IoT module basically consists of the functionality which demonstrates the process of the traffic light sequence. To achieve this functionality, the following items are used:

- Arduino Mega 2560 Board
- HC-05 Bluetooth Module
- Vari Board soldered with 3 LED bulbs (Red, Orange, Green)

Again, in designing the IoT module the Arduino prototyping platform is used in order to make the prototyping process easier. Arduino provides the triggering to light up the LED's in the traffic light sequence with the usage of the code written.

This data of the traffic light sequence is then transferred to the android application via the Bluetooth module HC-05. Android application then informs the blind person of the status of the traffic lights accordingly by giving an audio feedback of the present color of the light and whether it is safe to cross the road. Fig. 4 shows the main components of the IOT module setup.



**Figure 4. IoT module setup**

In all three LEDs (Green, Orange and Red) the positive end of each LED is connected to the digital pins 10,11 and 12 of the Arduino board respectively while the negative end is grounded by connecting a GND pin of the Arduino to the positive power rail of the bread board.

#### The Bluetooth module HC-05 has four main outputs:

- VCC, the positive voltage terminal (indicated in red) is given a +5V by connecting it to the +5V pin in the Arduino board.
- GND, the negative terminal (indicated in black) is grounded by connecting it to a GND pin in the Arduino board.
- TX, the transmitter of the Bluetooth module (indicated in yellow) is connected to RX, the receiver of the Arduino board. RX, receiver of the Bluetooth module (indicated in green) is connected to the TX, transmitter of the Arduino board.



**Figure 5. Final Implemented System**

#### F. Software Design

- 1) Programming the Arduino: Programming of the Arduino UNO focuses on the code in the smart cane in which the function of barrier detection is prioritized. It consists of the coding of the three IR sensors (left, center and right). The detected distance to the barrier from the IR sensors will be received by the Arduino UNO with the guidance of this coding. This programming part also helps the selection of the correct output which should be conveyed to the blind person via the smart phone. Programming of the Arduino Mega2560 focuses on the code of the IOT module. The traffic lights are shown in a sequence provided by the program written. It also assists in selecting the correct output regarding the status of the traffic lights which should be conveyed to the blind person.
- 2) Programming the Android App: For the programming of the Android App, the MIT App Inventor 2 is used. This App is equipped with the voice recognition capabilities which can be identified as the primary input method of the android application (Fig.6). This App is also capable of giving an audio feedback to the user which can be declared as the primary output of the android application. First of all, the Android App pairs up with the Bluetooth module. When paired up with the Bluetooth module HC-06 which is installed in the smart cane, the Android App is programmed to receive the data regarding the IR sensors and barrier detection. Then the App notifies the obstacles ahead by giving an audio feedback. When paired up with the Bluetooth module HC-05 which is a part of the IOT module, the Android App is programmed to receive the data regarding the status of the traffic lights. Then the App conveys the data by an audio output which helps the blind person to prepare himself to cross the road safely.

When the blind person needs to travel with the help of Google Maps, he has to give a voice command by saying “navigation”. Because of the voice recognition capability, the App opens Google Maps on the user’s smart phone. The removed areas of the screen protector used in the smart phone will enable the user to sense the icons that should be touched to give a voice command to the google maps of the destination that he wants to travel to and to make the google maps give an audio feedback of the turn by turn navigation of the path.

When the blind person needs to contact his/her guardian he just has to give a voice command saying “help”. This will send an SMS alert to a predefined number (the number of the guardian can be used) asking for help. This enhances the blind person’s safety.

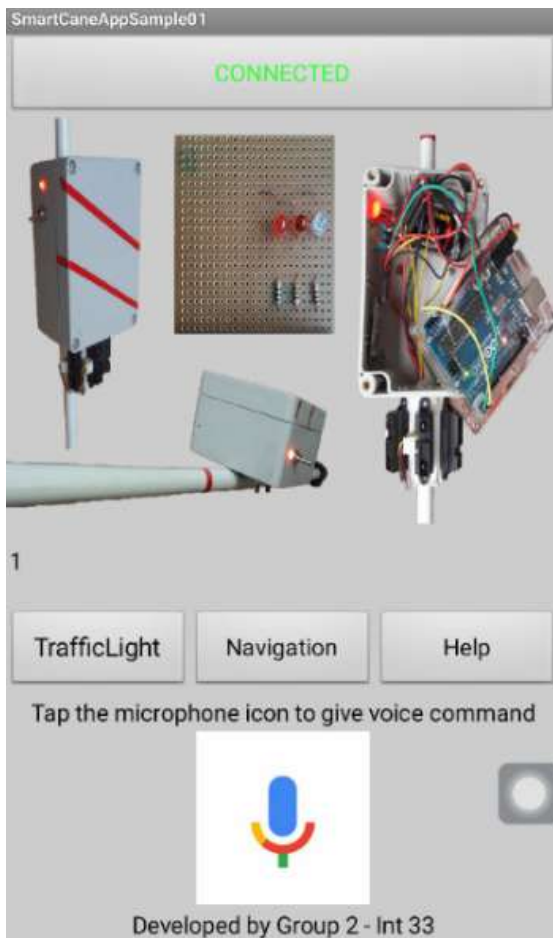


Figure 6. Interface of the Android App

## IV. EVALUATION

Summative evaluation was used as the evaluation method to find how the system functions and whether it is up to the expected level to fulfil the clients’ requirements. At the finalizing stage this evaluation was done to evaluate the product’s stability. In summative evaluation, a prototype with most stable build was shown to the client and the feedback was taken to find how far the system is success.

The intended target group of the smart cane were not employed for testing purposes as a safety measure, since the objective of this project is to design and construct a prototype smart cane. Following table and the figure depicts the overall results from the evaluation. The group reviewed the responses from 17 colleagues. According to the results, more than 95% of them have been satisfied by the below mentioned parameters taken by the group for analysing the developed system.

Table 1. Evaluation Results

Parameter	Customer Satisfaction of the Developed System
Smart Cane	15
Staircase Detection	16
IOT module	15
Water Detection	15
Android app	17
Traffic Light	9
Navigation	17
Help Option	17

Each IR sensor was tested by turning them on and sending signals directly in front of stairs as well as those within the angular range detectable by the sensors. The distance to a stair was computed by the program which was written for staircase detection of the smart cane. In this computation, the intensity of the IR signal beam reflected back to the detector by a stair was used through voltage measurements which is related to the distance to the stair and is given by the following equation:

$$\text{Distance} = (6762 / (i - 9)) - 4$$

where i is, an analog data collected by the IR sensor.

The water sensor was tested by turning it on and keeping it inside a water pit. The water sensor readings varied from 0-1024. Null value was indicated when there was no water.

For the testing purposes, we took the range from 100-700 because, due to the humidity we might get a positive reading. When the reading was in between 100 and 700 an audio voice output was sent to the user.

As this project focused on designing and constructing a prototype of smart cane, comparatively cheap IR sensors were used which can only measure distances up to about 80 cm. Hence errors were detected in the testing process. When implementing the actual smart cane, it is recommended to use IR sensors with a higher accuracy to minimize errors in distance computations.

## V. CONCLUSION

The project's ambition was to develop a cost effective Smart Cane to assist blind people. Detection of obstacles, stairs and puddles, water pits in the way of a smart cane user was found to be successful. However, integration of bus schedules into the App was not possible as such information is not available through the internet in Sri Lanka. This may be solved soon with technological advances expected to be incorporated by government mediation making it possible to achieve the objectives stated in the proposal regarding retrieval of transport information by the users of the smart cane. But the concept of IoT is conveyed with use of traffic light pairing.

In a similar manner traffic light signals, too are not equipped with IoT technology in Sri Lanka, making it a difficult task to incorporate such information in to the module which used in the smart cane developed in this project. This drawback too is expected to be overcome with technological advancements to be introduced in Sri Lanka soon.

Other than the above, a smart cane that can detect obstacles, puddles and the stairs in the way of a visually impaired person which can send signals to the user to enable him to navigate independently was designed and constructed in this project employing state of the art technology at a reasonable low cost.

Enhancing the functions that the smart cane already provides for the user can be done by using new advancements in technology. This approach makes it possible to overcome the shortcomings of the current smart cane. There are some certain drawbacks associated with IR sensors. With the advances in research, new IR sensors which are more accurate in determining distances

are being invented which can be used in place of the sensors that were used in this project. Also, two IR sensors can be complemented with an ultrasound detector in between, which although reduces the viewing angle, would give a higher accuracy in the distance determination.

Integrating Google Maps directly into the android app will make the navigation part even easier than it is in the current smart cane. Developments of cloud computing can be used to do the processing on the cloud and instantly give the feedback to the user. This will alleviate the problem of having to do a massive amount of processing either in the phone or the smart cane. New features can be added based on IoT and Internet of Everything.

## ACKNOWLEDGMENT

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# CHARACTERISTICS OF RAILWAY-ROADWAY LEVEL CROSSINGS AT COASTAL RAILWAY LINE IN SRI LANKA

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**Abstract** - Rail transportation is a safe, efficient, continuously operating sustainable transportation mode, in all-weather conditions, and light conditions. Along with these advantages, the role of rail transport has become increasingly important. Therefore, it is important to investigate the characteristics of the railway-roadway level crossings in Sri Lanka. Railway-roadway level crossings at coastal railway line from Aluthgama to Ambalangoda were visited to collect the roadway, railway, traffic, environmental, and crash data. Out of 51 crossings that observed in this study, about 94.1% of railway-roadway level crossings were facilitated with active safety measures. About 7.0% of railway-roadway level crossings were without gates and among them 33.3% of crossings were facilitated with passive safety measures and other crossings were under unsafe conditions. Several problems related to railway-roadway level crossing were identified. The collected data could be utilized to develop various statistical models for identifying relationships between the number of crashes and level crossing characteristics. It could be used to identify potential high-crash prone railway-roadway crossings and key factors which increase the number of crashes.

**Keywords** - Railway crossing safety, Level crossing features, Level crossing crashes

## I. INTRODUCTION

Rail transportation is a safe, efficient, continuously operating sustainable transportation mode, in all-weather conditions, and light conditions. Along with these advantages, the role of rail transport has become increasingly important. Railroads are one of the modes

that could be used to the movement of people and movement of freight during the journey from origin to destination. The traffic safety is a primary concern globally due to its magnitude of social and economic impact. Railway-roadway level crossings are crucial locations for transportation safety and efficiency in a ground transportation network. Railway-roadway level crossings are train-roadway vehicle crash-prone areas due to potential points of conflict between roadway traffic and trains as shown in Figure 1. Because of the substantial mass difference between train and roadway vehicle, the train-motor vehicle crash severity can be much higher than those of other types of traffic crashes.



**Figure 1. A Railway-roadway Level Crossing**

The Sri Lanka Railway (SLR) network comprises nine lines radiating from Colombo, which connect the most major population and industrial centers. Today SLR functions with almost 310 trains and facilitates about 0.34 million passengers daily (SLR, 2017). According to the SLR, its network covers 1960 Km with a 5' 6" broad gauges and

approximately 1186 level crossings can be observed in the country. SLR divided level crossings into three categories: protected level crossings, unprotected level crossings, and private level crossings. Protected level crossings can be further divided into four categories as follows.

1. Farm gates – This crossing is protected by gates, on both sides of the railway, which is completed with the farm type gate, when closed across the railway track.
2. Mechanically operated level crossings- These level crossings can be seen across the roads which having heavy traffic density and progressively interlocked with signals and plan to operate by gatemen.
3. Automatic Bell and Light - These crossings have no barriers but which are protected by road traffic light signals and audible warnings are provided for pedestrians without gatemen.
4. Electrically operated barrier - These crossings are protected by road traffic by light signals and a lifting barrier on the near side of the roadway on both sides of the railway. Audible warnings to pedestrians are also provided by the gatemen.

Unprotected level crossings are provided for some minor road- and path-crossings the railway line which are operated by police or railway staff. These level crossings are provided by all warning signals for pedestrians. These level crossings are also called bamboo gate level crossings. Private level crossings are provided as passage across the railway track for the sole use of the private owners of land whose right of a way or passage may have been intersected at the time of construction of the railway. These level crossings are padlocked by the owners.

The numbers of crashes at railway-roadway level crossings in Sri Lanka are increasing annually. In 2011, 2010, 2009, and 2008 numbers of crashes were 82, 75, 66, and 43 respectively (Mudugamuwa, 2012). Crashes at railway-roadway level crossings pose a serious problem throughout Sri Lanka as they account for a significant loss of lives.

Therefore, it is important to investigate the characteristics of the railway-roadway level crossings in Sri Lanka while identifying the relationships between crossing crashes and features of crossings. Such results can be used to recommend better crash mitigation strategies, thereby improving the safety at the level crossings.

## II. METHODOLOGY

Field surveys on railway-roadway level crossings were made at coastal railway line from Aluthgama to Ambalangoda to collect the roadway, railway, traffic, and environmental-related data. The location of the crossings, geometry, type of the gates, gate operator availability, warning signs availability, light signals availability, other traffic management system existence, safety precautions taken by the SLR, number of railway tracks, visibility issues, gradient of that roads, number of roadway lanes, angle of crossing, speed limit of trains and other related details were collected during the field surveys. Also, data on the daily number of trains, maximum allowable rail speed, and the roadway Average Annual Daily Traffic (AADT) were collected. The crash data from year 2009 to 2014 were obtained from the Police.

## III. RESULTS

Out of 51 crossings that were observed in this study, about 94.1% of railway-roadway level crossings were facilitated with active safety measures. About 7.0% of railway-roadway level crossings were without gates and among them 33.3% of crossings were facilitated with passive safety measures and other crossings were under unsafe conditions. If considering the crossing at C-class or D-class roadways in the study area, all the gates were operated by gate operators manually. A few factors which could be used to improve the railway-roadway crossing safety were identified. When considering the grade separation of roadway and railway at the crossing, about 52.9% of railway-roadway level crossings were having more than one meter sudden height difference and about 5.9% of crossings exceeded the two meter height of grade separation which can be a comfort reduction factor for the roadway users. Field observations also showed that some of the warning signs and the safety sign boards were fixed very close to the railway-roadway level crossings without considering the perception reaction time of the vehicles and this can be very dangerous in crossings with unsafe gates.

Table 1 shows the crash data collected from the Elpitiya police station and that were cross checked with the police crash database. When looking at the variation of crash data, it was obvious that after 2012, the number of crashes at the crossings from Aluthgama to Ambalangoda has been reduced. This may be due to the implementation of new gates for some unprotected railway-roadway crossings at that time.

**Table 1. Crossing Crashes from Aluthgama to Ambalgoda**

Crash Category	Year					
	2009	2010	2011	2012	2013	2014
Fatal	0	2	3	2	0	0
Injury	1	0	1	0	0	0
Property damage only	2	0	0	1	1	0
Total	3	2	4	3	1	0

## IV. CONCLUSIONS

The observed grade separations at the railway-roadway crossings need to be corrected by doing proper vertical alignments. Also, it is recommended to relocate the closely located sign boards at proper distances and those are needed to be properly visible for the riders during the night time. Using the collected data, various statistical models could be considered for identifying relationships between number of crashes and level crossing characteristics. Because of the random and discrete nature of crashes, Poisson regression is a good starting point for modeling. Crash prediction model for a railway-roadway level crossing is intended to

predict the likelihood of a crash occurring over a given period of time, and given conditions at the crossing. It is also used to identify potential high-crash prone locations and key factors which increase the number of crashes. These analyses may be crucial for traffic safety evaluation and management programs because this can be used to examine the performance of existing transportation infrastructure and purpose countermeasures to improve the safety.

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# INFLUENCE OF VEGETATION DENSITY ON VEHICLE SPEED AND POSITION OF ROADWAY

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**Abstract** - According to the World Health Organization (WHO), over 1.2 million people lose their lives each year in motor vehicle crashes and disable millions of people annually around the world. Based on crash data in the United States, single-vehicle collisions with trees account for nearly 25% of all fixed object crashes each year, resulting in deaths of approximately 3,000 people and making up approximately 48% of fixed-object fatalities. The injuries and fatalities due to single vehicle-collisions are a significant component of road crashes in Sri Lanka.

The objective of the study was to evaluate the drivers' speed selection and lateral position of vehicle from the presence of roadside elements within proximity to the roadway. Parameters affecting drivers' speed and lateral positioning of the vehicles on the road were chosen based on literature review. Random vehicles in each selected location were observed and the information on all the parameters were collected which identified using the literature review. Using the collected data, multiple regression models were developed. The models showed that on the lightly vegetated roadways, people drove faster and drove much closer to the edges of the road. When the landscape changed to more vegetated, people drove much slower and drove closer to the centre of the road. Developed models also predict the speed selection of drivers and lateral positioning of the vehicles on the roadway sections.

It was clear that the roadside vegetation influences the drivers' speed selection and positioning of the vehicle on the road. Therefore, it is a necessity that the road designers would consider the effect of roadside vegetation on designing the roadway sections. Ultimately, it would reduce the number of run-off-the-road crashes happening in the country.

**Keywords** - Vehicle position on Roadway; Vehicle Speed Selection

## I. INTRODUCTION

Motor vehicle transportation systems are primary infrastructure elements of modern cities, and transportation officials have reviewed roadside elements for potential safety risk because run-off-the-road collisions are significant contributors for traffic injuries and fatalities. Roadside vegetation, utility poles, traffic poles, guard rails, and sign posts are some examples for roadside elements. Roadside vegetation plays a critical role on mitigating negative impacts to the human and environment. Providing shade, leading to lower pavement temperatures and decreased emissions are some of the positives (Cole, 2013). Also, it provides positive psychological implications such as reduced stress, alleviated depression, and expedited recovery from injuries. Even though roadside vegetation provides such psychological and environmental benefits, they pose a potential risk to drivers when placed within proximity to the traveled way (Cole, 2013). When there is an open landscape without trees at the roadway, people drive faster, away from the road center [Antonson, 2009]. The objective of the study was to evaluate the drivers' speed selection and lateral position from the presence of roadside elements within proximity to the roadway.

## II. LITERATURE REVIEW

Previous studies relevant to the topic of "Impact of roadside vegetation to vehicle speed and lateral position in rural roadways" have been investigated to understand the parameters affecting to vehicle speed and lateral position.

Calvi and Alessandro (2015) checked the effect of the roadway environment to the driver and experiment was performed with a driving simulator. About 44 volunteer drivers participated for the study at least with four years of driving experience and at least having 3000km average annual driving distance on rural roads. The study was

developed considering five different geometrical elements including sharp left/right curves (100m radii), gentle left/right curves (400m radii) and a tangent section. A roadside configuration with no tress was assumed as the baseline. Speed of the vehicle and the lateral position were the dependent variables of the study. It was found that the more vegetated roadways drivers tend to travel in low speed near to the center line of the road compared to those of other road sections. Moreover the spacing of the trees did not affect for the lateral position of the roadway but not for the speed.

Knodler and Fitzpatrick (2016) has done a study to investigate the effect of clear zone size and surrounding vegetation density on driver speed, lateral positioning, and drivers' visual scan patterns. A driving simulator was used to collect data and 24 drivers who have 8.5 years of average driving experience and with average age of 25.6 participated for the study. Three clear zone variations (small- trees near the road edge, medium and large clear zone trees were at 2m, 6m respectively) and two vegetation variations (medium and dense) were utilized to have six combinations. Participants traversed a ten minute drive that consisting the above mentioned six combinations and four tangent sections, two right curves, and two left curves. Throughout the driving time, the driver's speeds and lateral positions as well as driver's eye movement were captured. Results showed that there were no statistically significant differences in speeds between the six combinations. Main reasons for this result was awareness of the drivers that they were in virtual drive and other was the speed limitation signs. Those signs were utilized to make the virtual environment more real, however eye tracking data proved that those signs were detrimental to the study. When horizontal scan patterns were analysed, it seemed to be that drivers used their peripheral vision to watch for hazards in the clear zone though it was assumed that drivers would scan a wider field of view with the increment of clear zone size. No statistically significant differences in lane positioning were observed during the tangent segment and straight or right curved sections when it was left curve, drivers drove almost a foot further from the edge of the road. However, the lateral positioning may be different, if the data will be collected in real situation.

Lankathilake and Amarasingha (2017) studied the effect of the roadside vegetation on vehicle in real situation. The main objective was to obtain the effect of roadside vegetation on drivers' speed selection and positioning of vehicles on the road. Two models were developed after

analyzing the gathered data. When doing the analysis roadside vegetation and utility poles were considered. Even though there is an impact from other factors such as traffic poles, guard rails, crash cushions, breakaway posts, roadside embankments, and sign posts, those were not considered due to their lack of continuity and difficulty of having data. Eleven variables were chosen which affect the speed and the lateral position based on literature review and interviewing licensed drivers.

To identify the critical variables, an online survey was conducted and some variables were selected to study further. Selected variables were proximity to roadside objects, vehicle condition, gender of the driver, age of the driver, passengers on board, number of pedestrians, width of pedestrian walkway, lane width, vegetation density, vehicle speed, and lateral position of the vehicle. Two roadway geometrical and three vegetation variations were selected for the study. Altogether there were six combinations. Form each combination, about 50 vehicles were observed and collected the data. Since the locations were identified in the same roadway section, the effect of lane width and pedestrian walking path, design speed were not considered as the independent variables. Speed of the vehicles was observed using a radar gun and the lateral position was observed using videos. Collected data were analyzed using the multiple regression method and was achieved a correlation between above mentioned parameters. Final results of the study showed that on straight roadway sections and changing vegetation did not affect the speed selection of the driver, but an increased vegetation density had a positive impact on the lateral position of the vehicle. At horizontal curved roadway sections, there was a significant effect of roadside vegetation to both speed and lateral position. A proper monitoring system was recommended to investigate the reaction of the drivers.

### III. METHODOLOGY

The study was planned to do for straight roadway sections. Therefore all the selected study areas contain straight roadway sections, but with different roadway characteristics. Parameters affecting drivers' speed and lateral positioning of the vehicles on the road were chosen based on the literature review and were tabulated in Table 1 with the definitions and were described following section.

- 1). Gender of the driver (GD): Driving pattern of a male driver compared to a female driver may slightly differ.

- Men and women show less difference in causing single-vehicle crashes, but women show a higher tendency to be at-fault in multi-vehicle crashes (Citron and Stamatiadis, 2008).
- 2) Age of the driver (AD): Considering age, drivers were categorized into three different groups: young, middle aged, and old. Age of the driver was identified with visual observation while she/he was driving.
  - 3) Vehicle condition (VC): Vehicle condition was defined as new, old, or in-between. Condition of the vehicle can be determined using the registration number of vehicle as in Sri Lanka, the registration numbers are issued in sequence order. Vehicles registered after year 2013, received three-letters following dash and four-numbers and the rest had two-letters or two- numbers following dash and four-numbers. The vehicles with two letters in the first part were registered between 2000 and 2013 considered as medium-aged and the vehicles with two numbers were considered as old vehicles. Vehicles with three letters in the first part of number plate were considered as new vehicles.
  - 4) Passengers on board (PO): When considering the safety of the passengers on board, drivers might be more selective on their speed and position on the road.
  - 5) Number of pedestrians (NP): It is a responsibility of a driver to ensure the safety of the pedestrian. If there are more pedestrians traveling on the sidewalks, drivers will gradually decrease the speed of the vehicle.
  - 6) Proximity to roadside objects (RO): The distance between roadside elements to the edge line of the pavement shoulder could be a varying factor in roads. If the distance is marginal, it would create doubt on drivers' mind on how to drive safely on the road.
  - 7) Width of sidewalk (WW): If the pedestrian sidewalk lane width is marginal, it would create a doubt on drivers' mind on choosing an appropriate speed on the road.
  - 8) Lane width (LW): if there is a marginal lane width, drivers will not have enough space to maneuver the vehicle on the road. Therefore, they tend to show down the vehicle when there is marginal lane width.

**Table 1. The parameters affecting the speed and lateral position of vehicle**

Parameters	Notation (Code)	Definition
Gender of the driver	GD	Nominal Variable; 1= "Male", 2= "Female"
Age of the driver	AD	Nominal Variable; 0= "Young < 25 yrs", 1= "Middle aged 26-50 yrs", 2= "Old > 50 yrs"
Vehicle condition	VC	Nominal Variable; 0= "New", 1= "Medium", 2= "Old"
Passengers on board	PO	Numeric variable; measured in numbers
Number of pedestrians	NP	Numeric variable; measured in numbers
Proximity to roadside objects	RO	Numeric variable; measured in meters.
Width of the Sidewalk	WW	Numeric variable; measured in meters
Vegetation density	VD	Nominal Variable; 0= "Light", 1= "Medium", 2= "Heavy"
Lane width	LW	Numeric variable; measured in meters
Vehicle speed	VS	Numeric variable; measured in Kilometers per hour
Lateral position of the vehicle	LP	Numeric variable; measured in meters
Presence of vehicles following	VF	Nominal Variable (1= "YES", 2= "NO")
Presence of oncoming vehicle	OV	Numeric variable, measured in numbers
Presence of guard rail	GR	Nominal Variable (1= "YES", 2= "NO")
Posted speed limit	SL	Nominal Variable (1= "YES", 2= "NO")
Shoulder Width	SW	Numeric variable, measured in meters
Vehicle flow	FL	Numeric variable, measured in equivalent passenger car units per hour
Vehicle type (class)	VT	Nominal Variable
Distance to an intersection	DI	Numeric variable, measured in km
Distance to a pedestrian crossing	DP	Numeric variable, measured in km
Radius of the Curvature	RD	Numeric Variable , measured in m

- 9) Shoulder width (SW): Shoulder width has a high influence for the lateral position of the vehicle as well as the speed because if the shoulder width is low, driver may see it as a risk and move towards the centreline of the road.
- 10) Presence of oncoming vehicle (OV): If there is an oncoming vehicle, the driver will try to move towards the edge of the road and lower the speed.
- 11) Presence of vehicle following (VF): The following vehicles may attempt to overtake the front vehicle.
- 12) Vehicle type/class (VT): Speed of the vehicle depends on its type. Normally heavy vehicles tend to maintain a low speed due to its size and the load.
- 13) Posted speed limit (SL): According to the Sri Lankan Law, speed limits have been implemented considering the vehicle class. If there is a posted limit driver may understand it as a warning to get prevent from a hazardous zone. Therefore, the speed may get reduced.
- 14) Presence of guard rail (GR): Having a guard rail beside the road confirm that there is no effect from the adjacent property. Therefore, drivers may tend to travel in high speed at the edge of the road.
- 15) Distance to an intersection (DI): Drivers always consider an intersection as a conflict place. Therefore they tend to reduce their traveling speed.
- 16) Distance to a pedestrian crossing (DP): Pedestrian crossing can be considered as a place with high probability for crashes. Hence divers reduce the speed of the vehicle at a pedestrian crossing.
- 17) Vehicle flow (FL): This is a primary parameter which affects the vehicles' speed.
- 18) Radius of the curvature (RD): Radius of curvature has a perfect positive correlation with speed and lateral position in the curved roadway section.

Vehicle speed (VS) and lateral position of the vehicle (LP) were the parameters under consideration. Data collection on all the parameters listed in Table 1 together with speed and, lateral positioning was carried out in different straight roadway sections in the same road. The speed of the vehicle was detected using a radar gun. A video camera was set up at each location to measure the

lateral position of the vehicle on the road. Lateral position of the vehicle was measured by analysing the videos recorded at each location. Vehicle registration number of each vehicle was observed to determine the condition of the vehicle. The width of the lane and the pedestrian sidewalk were measured using a measuring tape. The gender of the driver, the approximate age of the driver, and the passengers on board were also observed. Since, the locations were identified in the same roadway, the effect of lane width, width of the sidewalk, shoulder width, and design speed were not the variables. The traffic flow was determined based on the 15-minutes classified traffic counts at the same time of the data collection at each and every location. Quantitative data were collected on condition of the vehicle, vehicle type gender, approximate age of the driver, and vehicle condition. Speed of the vehicle, presence of following vehicles, presence of head-on vehicles, guard rail, distance to intersection, distance to cross-walk, number of passengers on board, number of pedestrians in the sidewalk, vegetation density, and lateral position were quantitative data. Vegetation density was determined analysing photograph taken at each site.

Multiple regression analysis was used for the analysis. Multiple regression is an extension of the simple linear regression. It is used to predict the value of the dependent variable based on the value of two or more independent variables. All the parameters which were defined in Table I were used for analysis.

## IV. RESULTS

Speed variation with varying roadside vegetation densities has been studied. The average speed on each location was approximately 35 Km/h. The variation of lateral position of each vehicle in varying roadside vegetation densities was also studied. The average lateral position values were shifted in the upward direction with the location change from light to medium. Average lateral position values in light and medium vegetation location are 3.3m and 2.5m respectively. Heavy vegetation density location has more scattered lateral position values when comparing to other two locations with an average of 3.3m.

The correlation matrix for the roadway section was developed to determine the interrelationship of independent variables. Then logistic regression models were developed using backward elimination technique. Developed models showed that in the lightly vegetated roadways, people drove faster and drove much closer to

the edges of the road. When the landscape changes to more vegetated, people drove much slower and drove closer to the center of the road. Developed models also predict the speed selection of drivers and lateral positioning of the vehicles on the roadway sections.

## V. CONCLUSIONS

The preliminary analysis in the study was conducted using the variance of vegetation density with speed and lateral position of vehicle. Increasing of the vegetation density had a positive impact on the increasing lateral position of the vehicle. Developed models also predict the speed selection of drivers and lateral positioning of the vehicles. Speed and lateral position of the vehicle depend on different types of variables including the driver characteristics, roadway characteristics, and weather conditions. It was clear that the roadside vegetation influences the drivers' speed selection and positioning of the vehicle on the road. Therefore, it is a necessity that the road designers would consider the effect of roadside vegetation on designing the roadway sections. Ultimately, it would reduce the number of ROR crashes happening in the country.

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# IMPROVEMENTS IN PEDESTRIAN FACILITIES AT MAHARAGAMA TO MITIGATE THE TRAFFIC CONGESTION

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**Abstract** - Traffic congestion at the busy intersections during peak hours is very high and the wastage of time, fuel and other resources of road users is a critical issue. This congestion cost in Sri Lanka is estimated around Rs. 12 billion per annum. High Level Road (A04) which is a main corridor out of the seven major transport corridors, pass through Maharagama junction. Due to infringement and inadequacy of pedestrian walkways and facilities, encroaching of pedestrians into the carriageway disturbing vehicle movement is a main reason for the traffic congestion. Therefore, a number of road traffic accidents occur daily. This paper illustrates the overall study carried out to determine a solution for safe movement of pedestrians in Maharagama city. The study was started by identifying the problem and continued with data collection conducting a vehicle count survey and a pedestrian survey. As the most feasible solution for the congestion, a pedestrian overpass was selected and justified using a decision matrix. The network and the stations for overpass system were decided considering the commercial centres, public related service centres and locations where high pedestrian movement is present. As the secondary data, 1: 10,000 digital data obtained from Survey Department including the land use in the area were considered. In designing the structure, the ultimate loading conditions, deflection, vibrational effects, materials needed for construction, aesthetic appearance and power needed for the system were considered. Width of the overpass was decided by considering the Level of

Service (LOS) for the pedestrians. Expected outcomes of the project are: improvement of vehicle flow, reduction of delay, reduction of road accidents and improvement of pedestrian safety at Maharagama.

**Keywords** - Pedestrian Overpass, Level of Service, Traffic Congestion

## I. INTRODUCTION

Pedestrian crossing is a place which is designed to guide and assist the pedestrian to cross a road safely. Pedestrian crossings can be at-grade or grade separated. In certain locations where pedestrian and vehicle movement is high, at-grade pedestrian crossings cannot be used because it would further increase the traffic congestion at that point. At such locations grade separated crossings are used.

Maharagama city is a highly-urbanized suburb in Colombo Metropolitan Region, located about 15 km from the commercial capital. National Youth Services Council, National Cancer Hospital, National Ayurvedic Hospital, Maharagama Railway Station and Maharagama Bus Stop are some of the important places in and around the study area.

Few of the main problems for the congestion in the city are random pedestrian movements across the carriageway and

the infringement and inadequacy of pedestrian facilities. This has caused mainly because street vendors have encroached the pedestrian walkways and road planners have neglected the pedestrian facilities in the design stage. The city is in a rapid development and the urban traffic congestion has become a serious problem in the area. It incurs both tangible and intangible costs to all road users as well as to the whole society.

## II. LITERATURE REVIEW

As observed in many urban areas, adequate pedestrian accesses have been forbidden due to various reasons. Unavailability of pedestrian facilities and infringement of the provided facilities by different parties are the most remarkable scenarios. Therefore, pedestrians have been forced to use the carriageway when there is inadequate supply. Kumara et al. (2014) state that when a vehicle travels at its cruise speed, and if the speed is interrupted due to interruptions due to pedestrian crossings, it decelerates to a minimum speed or which can be even a complete stop. Subsequently, the vehicle has to accelerate back to its original cruise speed. Therefore, when a vehicle undergoes a speed change cycle, it increases the Vehicle Operating Cost (VOC).

Proper design of pedestrian facilities can be contributed to increase overall efficiency of the transportation system. Liyanage (2010) has found the traffic volume, flow characteristics, vehicular speed and level of service of each route in Maharagama city center. He states that in the area the vehicle speed at the peak time varies from 13km/h to 33km/h, and the large pedestrian movement is at the Maharagama junction. That is because passengers have to cross at least one main crossing to walk to take the next bus.

Number of surveys have been done to find the types of problems, pedestrians face on the road. Some of them are lack of or inadequate capacity of pavements, obstructions on footways: roadworks rubbish bins and sacks, poor footway maintenance and buildings. Therefore, people waste their time on the road which could be used more productively. Amarasinghe et al. (2012), express that one of the major problems for congestion at Maharagama town is excessive pedestrian movement taking place due to number of wayside textile traders occupying town area as their business grounds. Also, this business community disturbs the walkways and pedestrians have forced to use the carriageways. Renfro (2007) points out that an overpass pedestrian system can improve the traffic

situation and realize the separation of people and vehicles. He further states that the system should be built based on existing public facilities and should optimize the local environment, guide pedestrians walking habits and create a smooth traffic safety. Pedestrian overcrossings serve many users, including bicyclists, walkers, joggers, inline skaters, and pedestrians with strollers, wheelchair users, and others. These facilities can represent one of the most important elements of a community’s non-motorized transportation network.

## III. METHODOLOGY

Transport system prevailing in the Colombo Metropolitan area has failed to cater the mobility needs of people due to many reasons. Inadequate pedestrian walkways and random pedestrian crossings disturbing the vehicle flow are few of them. In identifying this problem in the study area, the level of service of the vehicle flow was calculated as the initial step of the project. A traffic survey was used to calculate the level of service of vehicles in the High-Level Road and Old Road during peak hours. 0700h–0900h in the morning, 1200h–1400h in the afternoon and 1700h–1900h in the evening were taken as peak hours for the survey. After conducting interviews with pedestrians, businessmen and traffic police officers, locations where high pedestrian utilization occur were identified and their ideas were taken to find out the best solution for this problem. Using the gathered information, 5 major areas of extremely high pedestrian movement were selected (Figure 1).



**Figure 1. Locations with a high pedestrian movement in the Maharagama City**

Next, the capacities of pedestrians were determined at each point during different time slots and selected the places where highest pedestrian flow occur. After analyzing the survey results it was found that the points B, C and E had the highest pedestrian movement and those locations were selected to build a passenger crossing facility to mitigate the traffic congestion.

Some possible improvements identified to mitigate this problem were: an improved signalized traffic lights system, an underpass and an overpass. To select the best solution out of the three solutions, a decision matrix was formulated comparing different aspects such as cost, environmental impacts, effectiveness, safety, aesthetic appearance, construction feasibility and maintenance giving variable priority rating to each above aspect. And a quality rating was given on a scale from 1 to 5 where 1 is poor and 5 is excellent. From the decision matrix (Table 1), it was decided that a networked overpass will be the best solution out of the above solutions.

**Table 1. Decision matrix for deciding the best solution**

	Traffic lights		Underpass		Overpass	
Cost (0.2)	5	1	1	0.2	2	0.4
Environmental impacts (0.2)	3	0.6	2	0.4	4	0.8
Effectiveness (0.2)	1	0.2	5	1	5	1
Safety (0.2)	1	0.2	3	0.6	5	1
Construction feasibility (0.1)	5	0.5	1	0.1	3	0.3
Aesthetic (0.05)	3	0.15	4	0.2	2	0.1
Maintenance (0.05)	4	0.2	2	0.1	3	0.15
Total		2.85		2.6		3.8

When selecting the locations for access points for the networked overpass system, aspects such as land use, shortest path, connections to commercial and other important locations, utilization of existing infrastructure and access facilities were considered. Through a decision matrix, a lattice shell type truss bridge was selected as the type of the bridge (Table 2). Factors such as structural feasibility, the initial cost, ease of construction, maintenance cost and the aesthetic condition were considered and priority(P) was scaled from 1 to 5 where 1 is very low and 5 is very high and the quality (Q) was

scaled from 1 to 5 where 1 is very poor and 5 is very good to develop the decision matrix. Because of the less aesthetic appearance of the truss bridges, it was designed as a lattice shell type structure while restoring the concept of truss bridges.

**Table 2. Decision matrix for Selection of bridge type**

Bridge Type	Structural feasibility		Initial cost		Ease of construction		Maintenance cost		Aesthetic condition		Total Rating
	P	Q	P	Q	P	Q	P	Q	P	Q	
Cable Stayed	5	4	4	2	4	2	3	2	3	5	57
Truss	5	5	4	5	4	4	3	4	3	2	79
Suspension	5	2	4	3	4	3	3	2	3	5	55
Arch	5	3	4	4	4	3	3	4	3	4	67

Another decision matrix (Table 3) was developed to select the building material of the bridge. Considered aspects were given a priority rating(P) from 1 to 5 where 1 is low and 5 is extremely high and a quality rating(Q) on a scale 1 to 5, where 1 is poor and 5 is excellent. Steel, concrete and wood were the materials considered and steel was selected as the most viable material.

**Table 3. Decision matrix for Selection of Material**

Materials	Initial Cost		Service life		Ease of construction		Maintenance cost		Aesthetic Condition		Env.l impacts		TOTAL
	P	Q	P	Q	P	Q	P	Q	P	Q	P	Q	
Timber	5	4	4	1	4	2	3	1	2	3	1	5	46
Concrete	5	2	4	4	4	3	3	4	2	2	1	3	57
Steel	5	3	4	3	4	4	3	3	2	5	1	4	66

The energy requirement for the overpass network is governed by the energy required to run the escalators, lamps in the overpass and lamps at stations. To create a sustainable structure and to compliment the green

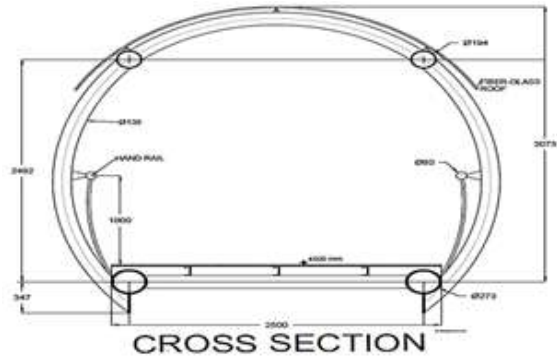
building initiatives, the bridge was designed to have solar panels mounted along the roof to generate the required power for lighting. Lighting calculations were performed according to the IEC 62305 standards and factors such as lighting area, lux level needed, lumen output of fittings was considered.

The suitable width for the overpass network was obtained by considering the pedestrian level of service and life span for the structure was taken as 30 years. According to the American Association of State Highway and Transportation Officials (AASHTO) guidelines a vertical clearance of 5.1 m was maintained in between road level and the soffit level of the bridge for the safe movement of vehicles. Handrails which help people steady themselves while moving were designed to have a height of 1.0 m. Use of pedestrian barriers is essential to prevent the pedestrians from directly crossing the High Level and the Old road at the Maharagama junction. It also helps to force pedestrians to use the overpass system. In fact, side barriers 1.14m height and 3.5m of steel trails were used for the design. Escalators were used at every access point to attract pedestrians to the system since pedestrian dislike climbing stairs. Figure 2 shows the use of side barriers, hand rails and escalators in the design.



**Figure 2. Escalator, side barriers and hand rails used at an access point**

The structure was designed for the critical path which is the longest path in the overpass network. All steel sections which used for the design are hollow circular sections and diagonal members are two radii circular hollow sections. Bridge was designed so that it can be pre-fabricated and assembled at the site. Sections were designed according to BS 5950 and software's such as AutoCAD 2013, SAP 2000 and Prokon 2.4 were used for the structural design and analysis. A typical cross section of the bridge is given below in the Figure 3.



**Figure 3. Typical cross section of the bridge**

The distance and total time taken (including waiting time) to move from one access point to another access point were found and the time saving occur when using the overpass was determined. Finally, the economic, social and environmental impacts that can cause due to the structure were determined.

## IV. RESULTS AND DISCUSSION

The pedestrian overpasses have a positive impact and have great potential of reducing number of pedestrian fatalities. At present, the role of existing pedestrian overpasses is not being fully implemented, because over 60% of pedestrians choose not to use pedestrian bridges for various reasons. Females use it more than males and children more than adults do. Reasons for not using an overpass include the discomfort, extra walking distance, high stairs, health reasons, or fear of safety. In order to mitigate these issues in this design, escalators were used in every access point. Also, to prevent random movements across the carriage way, side barriers were proposed. Foot bridges should be neat and clean and usable. Hawkers, beggars, banners, garbage should be removed.

It was observed that Maharagama area is congested during peak hours due to number of reasons. From the traffic surveys conducted it was identified that the level of service at the single lane (towards Kottawa) in the High-Level Road is D, level of service at the other lanes (towards Nugegoda) in the High-Level Road is B and level of service at Old Road is C. The area has a compound annual growth rate of 2.1%, and with the drastically increasing trend of the number of private vehicles, the problem will be much critical in near future. For the 2.5m width considered for the bridge, at the end of its life span the pedestrian level of service was obtained as C.

From the decision matrices formulated, it was decided that a networked overpass will be the best solution considering cost, environment impacts, effectiveness, safety, construction feasibility, aesthetic appearance, and maintenance out of the other solutions identified. Based upon the extensive research put forth and through the decision matrices formulated, the most suitable type of bridge to meet the needs of this structure was found to be a lattice shell type steel structure which is aesthetically pleasing.

Six major access points, (A, B, C, D, E and F) were selected for the proposed network of the overpass where access point A is close to the Market, access point B is the “Savina” building near the clock tower, access point C is near the Youth Center, access point D is between High-Level Road and Old Road, access point E is near the “Osusala” at the Old Road and access point F is at the Maharagama Railway Station. It is given below in the Figure 4 and 5.



Figure 4. Proposed stations of the networked overpass

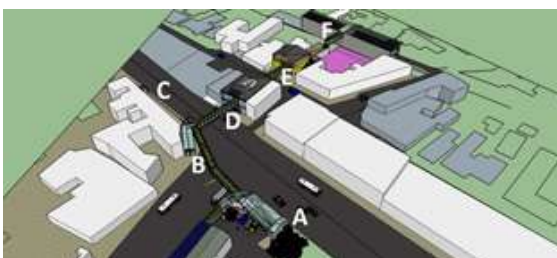


Figure 5. Proposed layout of the networked overpass

Access point A is the existing market building and it has enough space for the construction. This point will provide better access to Dehiwala, Moratuwa, Piliyandala bus routes and it will reduce the congestion in the High-Level Rad and Dehiwala-Maharagama Road.

Access point B has enough space for construction and it will avoid random pedestrian movements across the High-Level Road. Access point C will provide better access to Youth Center and it will reduce the congestion at point D. Point D interconnects the pedestrian movements across High-Level Road and Old Road.

Availability of a bare land gives enough space for the construction. Access point E provides direct access to Old Road and it will reduce the congestion of Old Road. Access point F which is the existing Railway Station has direct access to Pamunuwa Road. Availability of bare lands makes it easy for the construction of the bridge and with the proposed electrification of the railway track, demand at this point will be high.

The maximum span of the bridge between 2 nodes is 26m, and this path was taken for the structural design of the sections. The respective spans between 2 nodes in the overpass network is given in the following Table 4.

Table 4. Distance between nodes

Path	Span(m)
Access Point A- Clock Tower	18
Clock Tower- Access Point B	26
Access Point B- Access Point C	20
Access Point B- Access Point D	24.2
Access Point D- Access Point E	19
Access Point E- Access Point F	13

The total time saving occur when using the overpass is significant. The blue line given in the Figure 6 below gives the current pedestrian path connecting the access points and Table 5 gives the time saving between each access points in the proposed overpass.

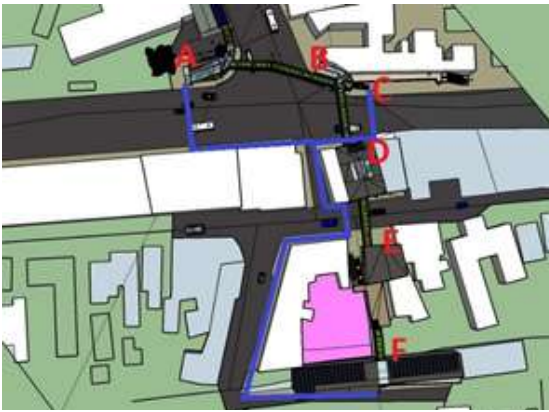


Figure 6. Existing pedestrian path and the path of the networked overpass

Table 5. Time Saving between access points

Acc. Pt 1	Acc. Pt 2	Path	Distance(m)	Total Travel time(mi n)	Time Saving
A	B	Existing	35	2.5	30%
		Proposed	46	1.7	
A	D	Existing	87	3.2	41%
		Proposed	60	1.9	
A	E	Existing	129	5.8	55%
		Proposed	109	2.6	
A	F	Existing	283	7.9	59%
		Proposed	153	3.2	
B	D	Existing	24	2.3	35%
		Proposed	30	1.5	
B	E	Existing	76	5.1	63%
		Existing	64	1.9	
B	F	Proposed	223	7.1	65%
		Overpass	108	2.5	
D	E	Blue	43	2.6	46%
		Overpass	27	1.4	
D	F	Blue	196	6.7	69%
		Overpass	77	2.1	
E	F	Blue	153	2.125	20%
		Overpass	50	1.7	

The total energy requirement for the whole overpass network was obtained as 474 kWh and it was decided to obtain the energy required for lighting using solar panels and to get the energy from the national grid to run the 8 number of escalators.

The main purpose of the designed pedestrian overpass is to reduce the traffic congestion by avoiding the pedestrian movement across the High-Level road and Old road, which disturb the continuous flow of the vehicles. This would mainly save the precious time of the road users and reduces the stressful driving experience of the motorists especially during peak hours. Therefore, the reduction of congestion in Maharagama due to the pedestrian overpass would be a great relief for the road users. One of the adverse social impacts of the pedestrian overpass would be that the beggars would tend to encroach in the overpass and the overpass would be a means of shelter for them. Legal actions need to be properly conducted to avoid this anti-social behavior of the beggars. For the construction of the designed pedestrian overpass, certain lands and buildings will have to be occupied. The building owners would not be willing to contribute their buildings for the construction, mainly because these buildings are used for their business work. Therefore, adequate compensation need to be paid for them. Also, relocation of their business places into the access points in the overpass system can be done.

## V. CONCLUSION AND RECOMMENDATIONS

It was observed that Maharagama area is congested during the peak periods due to number of reasons. One of the major reasons is the uncontrolled pedestrian movements where the walkway facilities have been used for unauthorized commercial activities. Also, failure to provide efficient public transport facilities lead to aggravate the traffic congestion encouraging unnecessary pedestrian movements. The ultimate goal of this project is to reduce the congestion due to pedestrian movements in the study area. In doing so three possible solutions were studied and selected best option as pedestrian overpass. Based upon the extensive research put forth by the design group, the most suitable type of bridge to meet the needs of this structure was identified as a lattice shell type design. Study was composed of field surveys to identify the best location for the facility, determination of Level of Service of the roads, analysis of topography of the study area, design of the overpasses satisfying the international

standards. In the Maharagama study area it was found out 5 places with extremely high pedestrian movements and crossings. Data collecting was carried out in two ways namely Study Desk and Site Reconnaissance method. Then the designing and analysis of the overpass was conducted by software such as SAP 2000, Autocad 2013 and Prokon 2.4 using the data gathered from the surveys fulfilling the relevant guidelines and codes of international standards. After developing this facility, vehicle flow rate in the roads will increase saving fuel, time and reducing the impact to the environment. Also, accidents causing for road users will reduce drastically while having a stress-free ride for motorists.

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# ANALYSIS OF TEST SECTION FLOW CONDITIONS OF LOW SPEED WIND TUNNEL

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**Abstract** - Low speed wind tunnels are preferred in experimental aerodynamics due to their ability of including the full complexity of real fluid flow while providing accurate, reliable data in the most economical manner. Determination of basic flow characteristics of a wind tunnel will lead to precise fluid measurement of more complex flows to be generated in the test section. Proper understanding of the distribution of fundamental flow properties along with turbulence level will lead to precise data interpretation and subsequent flow calculations.

The focus of the research is in determining pressure distribution and flow velocity through the test section of the low speed wind tunnel available at Kotelawala Defence University. This is done using a pitot static tube and boundary layer mouse connected to a liquid manometer. Test section is calibrated for speed setting by measuring static and total pressures. The longitudinal pressure gradient is obtained in order to make required buoyancy corrections. Dynamic pressure variation throughout the rectangular test section is obtained to include approximate survey of the walls as well. Generated results serve as a basis or reference in future experimentations in the low speed wind tunnel to make necessary corrections/allowances to assure precision.

**Keywords** - Boundary Layer mouse, Low speed wind tunnel, pitot static tube, pressure variation, test section calibration.

## I. INTRODUCTION

Wind tunnels serve as a powerful means of providing experimental information to solve aerodynamic and hydrodynamic problems. The primary activity of a majority of these experiments involve use of scale models

which in turn effectively predict the behaviour of the full-scale scenario.

Further small wind tunnels have proven to provide valuable information with regard to flow physics in many instances. Their simplicity and low cost in both construction and operation have made them attractive to users. In the study of flow patterns and how geometric parameter parametric variations affect them the low speed small wind tunnel is a useful tool (Barlow, et al., n.d.).

When air enters to the inlet section of the wind tunnel, the friction is developed in the wall of the wind tunnel. As a result a boundary layer is developed near the walls. Due to boundary layer development, the free stream pressure variation is created along the stream wise direction of the test section. When a body is tested in the wind tunnel, actual phenomenon of the flow properties around the body cannot be attained due to the free stream pressure variation in the developing zone. A study on boundary layer correction factors have been done in a wind tunnel having a 30 inch test section (Van Schielstett, 1934) while pitot-static tubes have been calibrated in even small tunnels (Spaulding & Marriam, 1935). It has been demonstrated that the effect of sidewall boundary layers as causing changes in both test Mach number and airfoil thickness that the latter effect is dominant at low speeds (Murthy, 1985). As difficult as it may seem at times to obtain a certain Reynold's number in small tunnels, the importance of having proper understanding of this similarity parameter cannot be understated (Donnelly & Streenivasan, 2012). Even though the experiment results may not be accurate at higher Reynold's numbers, devices such as hand thrown sports objects, small aircraft models and various instrumentation devices can be successfully tested (Tsuji, 2009).



In order to understand and estimate the flow properties, flow visualization through simple means such as smoke, tufts, or china clay can be accomplished. Since the pressure distribution over a given airfoil does not have drastic changes dependent on Reynold's number at angles of attack well below stall, pressure measurements yield useful results in tunnels of this nature. As per Barlow, et al many experiments concerning wind tunnel wall corrections are suitable for the small low speed tunnel as they are least affected by the Reynold's number. Separation and transition points indicate Reynold's number effects. However if both are fixed by virtue of natural shape of the object or through manipulation, then it is unlikely that there will be significant changes in Reynold's number.

## II. METHODOLOGY/ EXPERIMENTAL DESIGN

For steady, inviscid flow having a uniform velocity field far from any object that may be in the flow, it can be taken that the time derivatives of the Navier-Stokes equations for incompressible flow are equal to zero. The Reynold's number will be infinity and the curl of the velocity field must be equal to zero everywhere. Then the Navier-Stokes equation can be written as,

$$\hat{V} \left( \frac{\hat{V}^2}{2} \right) = -\frac{1}{2} \hat{V} C_p \quad (1)$$

Where symbols in carets are dimensionless variables, V is the nondimensionalized velocity which is equal to 1 and C<sub>p</sub> is the dimensionless form for pressure with the reference value shifted according to standard practice. Thus it can be stated that

$$\hat{V}^2 + C_p = 1 \quad (2)$$

Or equivalently,

$$p + \frac{1}{2} \rho V^2 = p_\infty + \frac{1}{2} \rho V_\infty^2 \equiv p_{tot} \quad (3)$$

Is the classical Bernoulli equation which is the base for low-speed wind tunnel experiments and for most speed-setting systems (Ristic, Isakovic, Ilic, & Ockoljic, 2004). Thus the velocity could be obtained through pressure difference measurement,

$$V_\infty = \sqrt{2(p_{tot} - p_\infty)/\rho} \quad (4)$$

In real flows, the effect of shearing or viscosity is to be taken into account, especially in case of flow adjacent to solid boundaries. When fluid elements pass over a solid surface (such as test section walls) fluid elements right adjacent to the wall will be in the 'no-slip' condition, whereas fluid elements immediately above will be at a retard state until such time that they are able to overcome the shearing effect induced by the wall. Thus a boundary layer will be created where fluid elements will be at lower velocity than the free stream flow (Schlichting & Gersten, 2017). The velocity of fluid increases from zero velocity on the stationary boundary to the free stream velocity of the fluid in the direction normal to the boundary. Fluid elements at the outer edge of the boundary layer will be almost close to potential flow velocity (Anderson, 2007). Assuming zero pressure gradient along the plate and uniform external velocity, the shearing stress is given by the Von Karman integral momentum equation,

$$\tau = \frac{d}{dx} \int_0^\delta (Vu - u^2) dy \quad (5)$$

where δ is the boundary layer thickness and u is the local velocity. Distance along and perpendicular to the surface are given by x and y respectively. For laminar boundary layers over a flat plate, Blasius solution to the flow governing equations give that boundary layer thickness,

$$\delta = \frac{5x}{\sqrt{Re_x}} \quad (6)$$

The retarded flow inside the boundary layer acts as a partial obstruction to the free stream flow thus deflecting the streamlines external to the boundary layer by the displacement thickness,

$$\delta^* = \frac{1.72x}{\sqrt{Re_x}} \quad (7)$$

An index that is proportional to the decrement of momentum flow due to the presence of the boundary layer is given by the momentum thickness,

$$\delta^* = \frac{1.72x}{\sqrt{Re_x}} \quad (8)$$

It is the height of a hypothetical stream tube which is carrying the missing momentum flow at freestream conditions.

### III. RESULTS AND DISCUSSION

The experiment is conducted in the Educational Wind Tunnel at the Department of Aeronautical Engineering of Kotelawala Defence University. It is a open circuit, low speed wind tunnel with a speed range of 4.5 m/s to 65 m/s. The test section dimensions are 30.5 cm x 30.5 cm x 60 cm. The four major duct components are the contraction, the test section, diffuser and fan housing. The 8.3:1 contraction ratio of the tunnel is a major contributor to its high performance and low turbulence level. The test section side wall has a divergence of 0.159 mm to compensate for boundary layer development (Aerolab LLC, 2013).

#### A. Speed Setting

When calibrating the low speed tunnel for speed setting, the experiment set up consists of the tunnel mounted with a pitot static tube. The test section is otherwise empty since the presence of pitot static tube and model will cause induced flow. The pitot static tube used in this experiment reaches 6.6 cm forward of the bend, extending 33 cm to the bend. It consists of a rounded-tip total-pressure tap and six static ports. The fan speed is controlled via a Variable Frequency Drive (VFD) and pressure readings are obtained for speeds ranging from 500 to 1500. The experiment was repeated four times and the results are shown in figure 1.

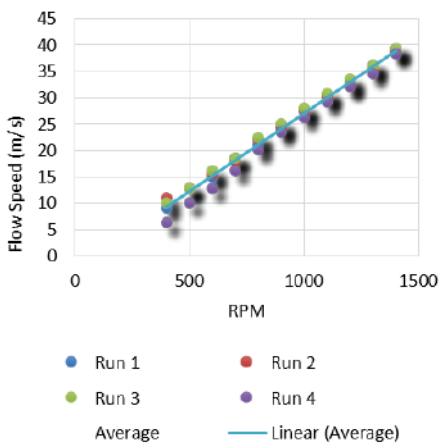


Figure 1. Variation of Velocity with Fan speed

#### B. Pressure Variation

The next step in the experimental procedure is to analyse the flow uniformity through the cross section of the test section. As per Barlow, et al (1999) the local dynamic pressure should not deviate more than 0.5 % from the mean dynamic pressure at the cross section of interest. Thus it is important to understand the interferences that the measurement device, in this case the pitot static tube, pose on the accuracy of results (Assato, Fico Jr, & Girardi, 2003). In the present experiment pressure variation in the direction perpendicular to the flow was measured via the pitot tube. The variation of dynamic and static pressure from mid-point of the test section towards the side walls is shown in figures 2 and 3 respectively.

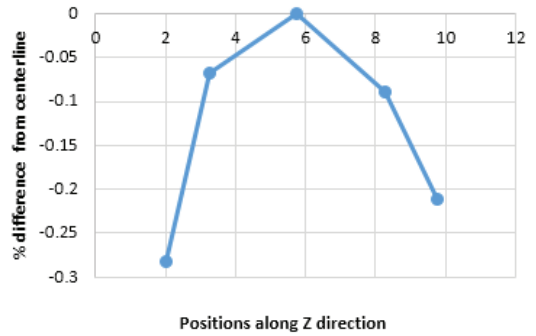


Figure 2. Dynamic pressure variation

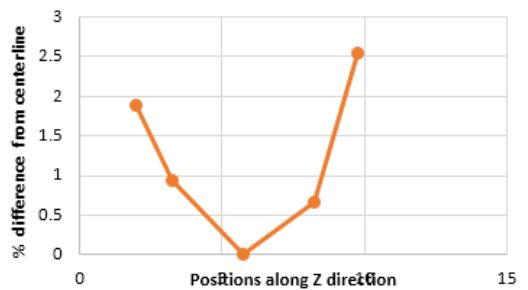


Figure 3. Static pressure variation

It is seen that the deviation of static and dynamic pressure in the direction perpendicular to flow at tunnel midsection does not exceed 0.3 %.

#### C. Wall Boundary Layers

Wall and surface boundary layer profiles were generated by obtaining readings through a boundary layer mouse.

The mouse has 10 total pressure probes that ascend on an angle and cover a width of 25.4 mm and a height of 6.1 mm. The probes are approximately 1.22 mm apart along the diagonal. Readings were taken for 6 equally spaced positions along the wall and 9 positions along the surface (base) of the test section for fan speeds ranging from 500 to 1500. The boundary layer velocity profiles for three points measured along the base of the test section in the direction of the flow for a fan speed of 500 rpm are shown in figure 4.

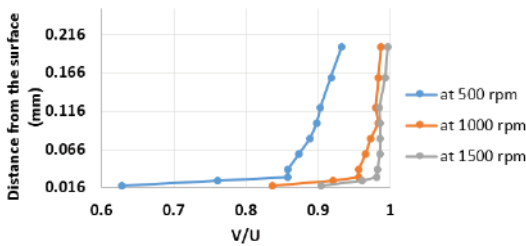


Figure 4. Boundary layer profiles of the start of the test section base

Velocity in the boundary layer at a constant height above the surface is shown in figure 5. The height of consideration is 0.06 mm above the base of the test section. The transition region for the three speed settings occurs around the same region: immediately aft of mid test section.

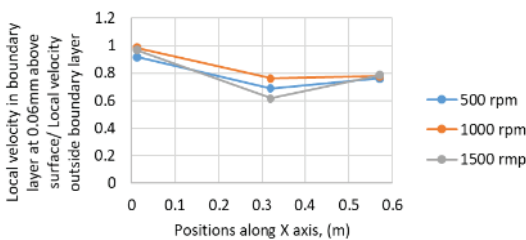


Figure 5. Velocity in the boundary layer at a constant height above the surface

The variation of boundary layer properties for the three different speed settings for the wall and surface (base) is illustrated in figures 6 to 11.

1. Variation of boundary layer thickness on the wall and surface:

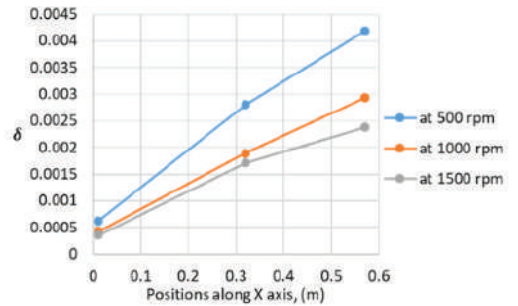


Figure 6. Variation of boundary layer thickness on the surface

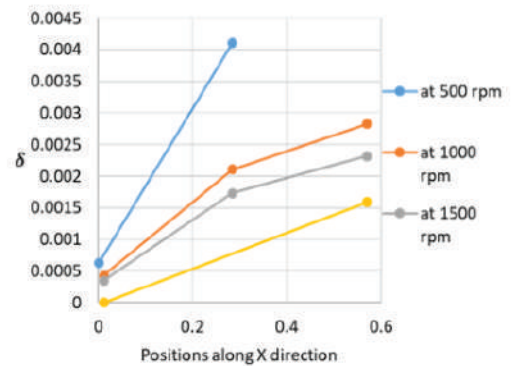


Figure 7. Variation of boundary layer thickness on the wall

Figure 7. Variation of boundary layer thickness on the wall

2. Variation of displacement thickness on the wall and surface:

The variation of boundary layer properties along with wall and surface of the test section are inspected. The divergence of the side wall is taken into account and represented as a correction factor.

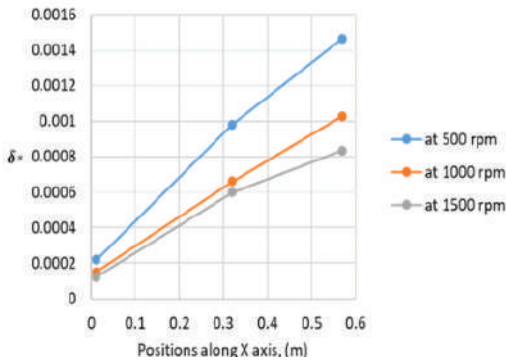


Figure 8. Variation of displacement thickness on the surface

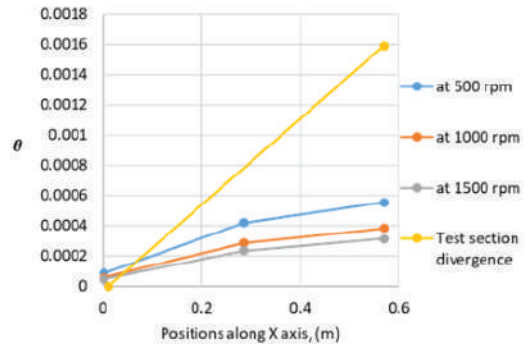


Figure 11. Variation of momentum thickness on the wall

The percentage reduction in the stream tube downstream of the test section is summarized in table 1 for the surface and table 2 for the side walls taking into consideration the divergence of the test section.

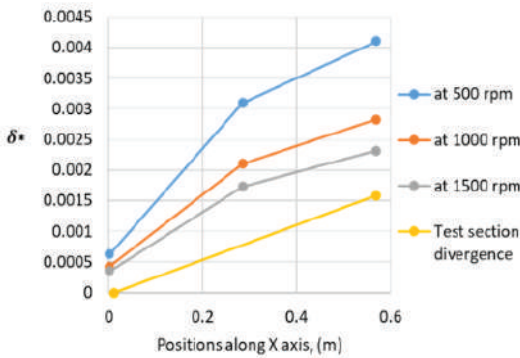


Figure 9. Variation of displacement thickness on the wall

Table 1. Percentage reduction in the stream tube downstream of the test section for the surface

Setting	% Due Boundary Layer Thickness	% Due Displacement Thickness	% Due Momentum Thickness
500 rpm	1.2	0.4	0.16
1000rpm	0.86	0.29	0.12
1500 rpm	0.65	0.24	0.092

3. Variation of momentum thickness on the wall and surface:

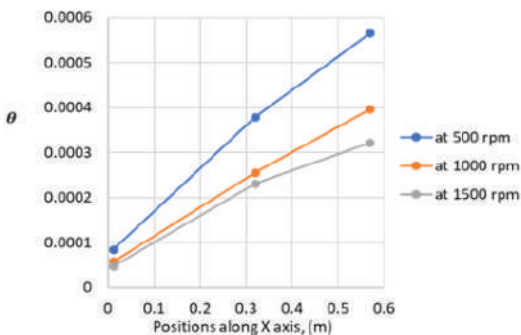


Figure 10. Variation of momentum thickness on surface

Table 2. Percentage reduction in the stream tube downstream of the test section for side walls

Setting		500 rpm	1000rpm	1500 rpm
% Due Boundary Layer Thickness	Measured	2.62	1.86	1.46
	Corrected	0.84	0.4	0.24
% Due Displacement Thickness	Measured	2.74	1.86	1.52
	Corrected	0.84	0.4	0.24
% Due Momentum Thickness	Measured	0.32	0.24	0.2
	Corrected	-0.36	-4	-0.43

It is seen that at low flow speeds the reduction of the undisturbed stream tube downstream of the test section due to boundary layer formation on the surface is approximately 1 %. For the side wall the effect is minimized by the inbuilt divergence of the test section.

### III. CONCLUSION

Three basic characteristics including speed settings and boundary layer properties of air flow in the test section of a low speed wind tunnel were analysed. As per the results obtained it is seen that the wind tunnel free stream velocity along the stream wise direction is constant, and is accelerated in the downstream direction. The reduction in flow area due to boundary layer formation was observed in the downstream direction as well.

With existing limitations in control and measurement, the results show that even though the flow parameters are subject to time dependent fluctuations, they can be neglected for educational purposes for which the tunnel is used presently. Boundary layer development is present but not significant so as to interfere with primary measurements which are obtained at mid height and width of test section at present use. When utilizing to its full potential however, adequate turbulence and wall corrections need to be incorporated to ensure accurate results.

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*Built Environment  
And Spatial Sciences*

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“GLOBAL SPACE, LOCAL PLACE:  
PROTOCOLS FOR NEW WORLD ORDER”

## SESSION SUMMARY

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The session theme was “Global space, Local place – Protocols for a new world order” Technical session of the department of Spatial Sciences was chaired by the dean of the faculty of geomatics in Sabaragamuwa University, Dr. HMI Prasanna. The speakers of this session were Mr. SAHM Samarapperume, Squadron Leader GDI Sanjeewa, Miss. HUK Dilanjani, and Mr. KLP Hemantha. Mr. SAHM Samarapperume is the student of Faculty of Geomatics, Sabaragamuwa University and the title of his speech was “Estimation of Sea Level Rise in Colombo with Satellite Altimetry Data”.

He discussed the several possible negative impacts of sea level rising and importance of determination of sea level rising. He mentioned how sea level raised during last 20 years around Colombo and it was about 2.51 mm per year according to the satellite altimetry data. Also, he confirmed that altimetry measurements can be successfully used to analyse the long-term sea level changes. Sqn. Ldr. GDI Sanjeewa from Center for Research and Development-Ministry of Defence was the second presenter of his technical session.

The title of his speech was “Acquire high resolution aerial images for railway mapping by using quadcopter”. This study conducted in railway track between Panadura to Veyangoda included 64 kilometres and one main

advantage of the findings is acquisition of extremely high spatial-resolution imagery with minimum cost. Miss HUK Dilanjani is lecturer in Department of Environmental Management, Rajarata University of Sri Lanka and her speech was conducted under the title of “Preparation of landslide hazard zonation map in upcountry railway line Using GIS & Remote Sensing”.

The objective of her study was to the preparation of a landslide zonation map and identifies the landslide high-risk areas from Idalgashinna to Bandarawela along the railway line. Data analyse was done by using GIS software and different range of risk area were identified by her using the analysed data. She also mentioned that the most of the high and very high hazard class areas were found occupying the areas of the railroad. Last speaker of the Spatial Science’s technical session was Mr. KLP Hemantha, and he is government surveyor of Survey Department of Sri Lanka. His speech was “Automatic Data Extraction of Survey Departmental Hardcopy Documents” and it was very interesting topic for the audience. He specified the difficulties of maintaining hardcopy documents and the importance of digital documents. Arc GIS, Micro Soft word and text files were used for this data transferring and final results will be digital Cad drawing files of Plans, Shape files of Plans, Word documents and excel sheets of Tenement Lists.

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*Plenary  
Speeches*

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# GLOBAL SPACE, LOCAL PLACE: PROTOCOLS FOR NEW WORLD ORDER

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Not like other industries, the construction industry has without a doubt never passed through a prime revolution with the development of new technology. As a result of that the productivity within the industry remained static over the last 30- 40 years. However, this situation is progressively changed and it can be predictable that a dramatic change will be there very soon and some preliminary changes are already taking place. Although, these are not yet on a sufficiently wide scale they have been addressed many aspects of the construction industry over recent decade.

Therefore, it is a clear fact that in few years definitely there may be a new world order in construction due to the impact of technological as well electronic innovations and with it new protocols in the future. The key of these new movements is basically 'digitalization'. Most of the construction projects are incorporating systems of digital sensors, intelligent machines, mobile devices, and new software applications recently. One of the major transformation is integrating with a central platform of Building Information Modelling (BIM) and it is practicing successfully even in few large scale local projects. Further, the construction procurement methods such as Construction Management, partnering combined with PFI/PPP have emerged and used in most of the local infrastructure developments.

As construction projects significantly contribute to the environmental issues due to its massive consumption of energy and other natural resources during the whole life cycle of the project, the sustainability and green building concepts have been gradually incorporated. One of the new aspect being considered throughout the last few years is the 'climate responsive architecture' instead of using fossil power for heating and cooling requirement of the building. Further, due to the extreme urbanisation in the last decade most of the major cities in the world has become congested and unplanned.

Several solutions have been tested by the planners and the succeeded outcome is the "Smart City" concept. Smart cities are developed urban areas designed with a perspective of creating high quality of life by using digital technologies or information and communication technologies (ICT). There are more than 250 smart city projects over the world and the majority of projects are in Europe. This concept is already brought to the local context and it will become reality in the near future.

**Keywords** - Construction Industry, Technology, Urbanisation, Sustainability

# PROTOTYPE UBIQUITOUS VISUALIZATION SYSTEM BASED ON AUGMENTED REALITY WITH MOBILE PLATFORM

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With the rapid development of mobile Internet, outdoor augmented reality system is used in the more and more scenarios, such as social networking, shopping online, entertainment, etc. Augmented reality system is at the heart of the design of the tracking and register algorithm, the mainstream algorithm is mixed tracking registered thought, the visual identification tracking registration is the key in hybrid registration algorithm, the traditional algorithm relies on extracting the feature points, but the large amount of calculation and low accuracy affects the efficiency of tracking and register. Along with the deep learning thought in the field of computer vision, the image recognition model based on convolution neural network has also been widely used, and experimental results show this new algorithm greatly improves the image recognition accuracy and efficiency.

This paper studies many convolution neural network models for image classification and target detection of, analyses the advantages and disadvantages of each model, and on the basis of SSD excellent convolution neural network (single detection model) model changes the front three layers network structure, reduces the depth of the network, designs the different aspect ratio of the default frame, to simplify the model used to identify outdoor

geographical target. Referred to ImageNet and PASCAL VOC 2007 training sets, this paper collects experimental data and designs the training and prediction data sets, and then trains this simplified model on deep learning platform MXNET, as a result, the simplified SSD model, the mAP reaches 58.2% and an image processing time is 0.03s.

This paper uses the deep learning thoughts for solving the problem of the tracking and registered in mobile augmented reality system, develops a prototype system with based on sensor of visual perception and visual identification based on the deep learning, this system is using local mobile client mode, takes advantage of the android mobile phone posture and sensor system to obtain the current position information, and the trained simplified SSD model is used as a image recognition of engine, uses GPU to complete the calculation process, in addition, designs of a 2d and 3d information for the local geography target and provides a simple interaction pattern. Finally, in the actual test, the time of process images reach to 1.5s and target recognition confidence is at around 90%.

**Keywords** - Outdoor AR System; Deep Learning; CNN; SSD Model

# MODELLING THE RELATIONSHIP BETWEEN SPATIAL CHARACTERISTICS OF URBAN LAND USES AND HOUSEHOLD TRAVEL PATTERNS (A CASE STUDY OF COLOMBO DS DIVISION)

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The city is considered as a complex system with the interaction of numerous sub systems and transportation, which is the main crucial sub system of urban area that determines the activities (Handy, 1998). Some of burning issues in urban area at present had significant influence on direct and indirect connections with lack of integration of land use and transport (Litman, 2012). Land use and transportation system are considered as two most important systems that determine the function of the area.

The relationship between the land use and transportation has been accepted within many disciplines such as urban planning transport planning, geography and economy. Different strategies such as job housing balance, transport oriented development, transit villages, smart growth, etc., have been adopted in the present urban planning as alternative ways to integrate the land use and transportation more effectively (Xueming, 2013).

This research reflected on the relationship between land use characteristics and household travel pattern within an urban area by considering household socio-demographic factors. The study was carried out within the Colombo DSD area in Sri Lanka to estimate the relative importance of various land use characteristics on travel pattern. Household questionnaire survey was carried out to identify the general household travel pattern with the Colombo DSD area. Multiple regression modelling technique, ArcGIS and SPSS were utilized to conduct the required land use and travel pattern analysis. The relationship among spatial characteristics of land uses and household socio economic characteristics on the household travel pattern was evaluated by using Pearson correlation analysis and stepwise multiple regression analysis.

**Key words** - Land use, Travel Pattern, Correlation Analysis, Household Level

# ROLE OF PROFESSIONALS IN DEALING WITH ROAD TRAFFIC ACCIDENTS

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According to the information published by the World Health Organization (WHO), road traffic accidents is responsible for nearly 1.3 million deaths per year around the globe. Further, they mention nearly 50 million critical injuries are also report due to road traffic accidents. Though proper and accurate calculations are not possible for economic analysis, many research say that nearly 1.2 % of GDP is wasted because of traffic accidents.

Though it is a common practice to blame only one or two groups as responsible for accidents, many research prove that effect of various contributory factors at different contribution ratios are responsible for a given road traffic accident. Many parties responsible for traffic accidents can be named using the better "P" such as Pedestrians, Police, Politicians, Parents, Principals, Professionals etc.

Many research are carried out related to road traffic accidents concentrated on the Four "E" concept. It is Engineering, Education, Enforcement and Encouragement. Under such circumstances, I would like to present findings of some research work carried out during last few years to highlight the effect on attitude towards safety gears by drivers, safety of school children, self-reported angry behaviour of drivers, safety at railway crossings, effect of road markings on driver behaviour etc. to highlight the relevance of different angles and aspects of road safety.

As such the attempt of this presentation is to highlight the complex nature of road safety related issues and to encourage professionals of different disciplines to work as a team to eradicate this menace.

# EMERGENCY MAPPING OF MEETHOTAMULLA GARBAGE DUMP COLLAPSE

**SDPJ Dampegama**

Additional Surveyor General, Survey Department

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An unexpected collapse of Meethotamulla Garbage dump has occurred on 14th April 2017 at about 1500 hrs. This caused 32 deaths and complete destruction of about ninety buildings / structures and displaced about 1750 persons. This paper presents technologies and methodologies used to create emergency maps for rescue missions, methods for mitigation of further collapse and methods of monitoring and remedial actions to stabilize the dump site to prevent future collapses.

The whole process was sub divide in to four steps as follows.

- Locate the positions of the houses precisely in order to make necessary attempts to rescue trapped persons pinned under the dump slide.
- Identification of danger zones and evacuate residents and properties to prevent from possible collapses in future.
- Make necessary actions to monitor and stabilise the dump site.
- Identification of ownership of the damaged properties in order to pay compensation and other relief measures. The first priority was to locate the houses buried under garbage slide. As

about 35m height column of garbage along the south-east ridge of the garbage dump has collapsed on to the houses which were built closer to the foot of the garbage dump. It was very difficult to get reliable and consistent location of the houses buried under the dump from the evidence of the eye witnesses who are in panic status.

This presentation describes the methodology and tools utilised to pinpoint the locations of the buildings buried under the garbage. The stability of the garbage dump which was not collapsed to be envisage. The technology used to monitor the possible movement of the garbage dump is also described in this presentation. The ownership of the area under the danger circle is to be investigated for payment of compensation and relief distribution. A land information system was also created in order to achieve the above task. This paper present wide spectrum of technologies such as Lidar imagery, Point clouds from drones and precise positioning using continuously operated reference systems in detail.



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# *Medicine*

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“Changing Global Environment; Challenges and Opportunities in Medicine”

## SESSION SUMMARY

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The theme of the session was changing global environment; Challenges and opportunities in medicine. The plenary session was co-chaired by Senior Vidyajothi Prof Rizwi Sheriff from the department of Clinical Sciences, faculty of medicine, KDU and Senior Prof T.R Weerasooriya, Head of anatomy, Department of Pre-Clinical Sciences, Faculty of Medicine KDU. The speakers of the plenary session were Prof Saroj Jayasinghe, Prof Sarath Kotagama, Prof Bandula Wijey and Prof Malik Peris.

Prof Saroj Jayasinghe, from the department of Clinical medicine, from the university of Colombo spoke on wars between states and global health. In his speech he pointed out the fact that wars between states could easily and completely undo all health goals and Sustainable Development Goals (SDGs) agreed upon by the world; yet decreasing the wars between states have not made it to the SDGs, despite the attempts made by various scholars and activists worldwide. Prof Jayasinghe went on to point out the long term and short-term effects of chemicals used in war such as Agent Orange which was used in Vietnam war. Further, he pointed out how healthcare facilities become non-functional or dysfunctional in conflict areas.

He then pointed out that the UN Security Council, the most powerful body of the UN with the five permanent members (USA, UK, China, France, Russian Federation) holding veto power has unlimited powers vested on them in deciding upon wars between states. While these countries are also the biggest manufacturers of arms, other countries such as Norway and Sweden who uphold democracy are among the biggest manufacturers of small arms. This could be one reason why reducing wars between states are not taken up at powerful international organizations.

While Sri Lankan scholars have attempted at responding to this need through attempts such as Hikkaduwa declaration, which was a global petition, Prof Jayasinghe emphasized that KDU is privileged in making a global initiative on this through producing a scientific knowledge base on this area.

Prof Sarath Kotagama from the University of Colombo spoke about the future of elephant conservation. Prof

Kotagama started by highlighting the strong connection between elephants and Sri Lankan and Asian culture as a whole. Elephants have been regarded as a symbol of prosperity and strength from ancient times and have been ascribed celestial status as with Lord Ganesh, in addition to being a part of the cultural rituals such as "perahera" for thousands of years.

The recent statistics have shown an increase in the population of the elephants due to the improved feeding habitats for them due to human actions. Further, elephants have lost their home range due to human settlements.

The traditional methods such as electric fences, and thunder flashes which adds to the huge public costs of compensations provided due to human elephant conflicts, cannot be justified as these attempts have not solved the issue at hand. The measures taken should always take in to account that measures taken for a decreasing elephant population cannot be used for controlling and increasing one.

Therefore, if we do want our elephant population to continue Sri Lanka, we will have to adopt methods of co-existence with the elephants. Methods such as crop fences have been used for this purpose. In addition, further planning of human settlements should also take in to account the elephant home range. The co-existence methods would not only protect the people from elephant attacks but also would open new modes of income such as tourism. These methods are being adopted by the department of wildlife conservation and the process of integrating these techniques to the society has been accelerated.

Prof Bandula Wijey, ambassador of science, technology and innovation for Sri Lanka, spoke of Global health care on the horizon and imminent challenges. He started off his talk by pointing out the large medical engineering industry of Texas, US which is larger than the Sri Lankan economy itself and of which he is a part of.

Population growth as a result of the innovations in agricultural and food technologies have brought in new problems with it. As time passed on, human kind also made

new innovations such as the discovery of germ theory and the advent of antibiotics. Further with the current world population reaching a six billion, people appear to spend disproportionately large amounts of money on health care compared to other need such as food.

In most of the countries including US and Sri Lanka health care is focused on “break – fix” model where when something goes wrong with a person it is fixed via treatment. Yet the world is steadily moving towards preventive healthcare where the focus is preventing health issues. Further, the world is moving on to “personalized medicine”, where treatment methods area customized to individual genetic and biological make up. In Sri Lanka, too there is a growing interesting on this field even at the level of the Ministry of health.

Prof Wije further pointed at the digital technologies, where the patient histories, possible treatment methods, drug interactions etc. that is required in making treatment decisions are available in a digital format such as in IBM Watson computer, supporting the treatment decisions of a doctor. In near future, digital methods and other technological innovations will be heavily integrated to health care systems increasing and improving the efficacy and precision of a doctor and today’s medical students should be equipped to work with these future trends.

Prof Malik Peris from the University of Hong Kong spoke of emerging infectious diseases: the neglected dimension of global security. He recollected that throughout the

history there have been many historical records of infectious diseases such as the “Black Death “, in Europe and “Rathakshi Uwadura” in Sri Lanka. During the 20th century with small pox being eradicated, and the advances of antibiotics many thought the burden of infectious diseases was coming to an end. Yet, the infections seem to attack the human kind again. With diseases such as HIV, SARS, Zika, Ebola etc. Among these most are “Zoonoses” infections, which means that they are contracted from animals to humans.

While agricultural and animal husbandry related production has increased, while increasing the risk of infectious diseases; at the same time air travel is also in the increase, which makes it possible to transfer an infectious disease from one location to another within a very short period. To add to the risk is the fact that most of these outbreaks cannot be predicted. Such diseases affect socio-economic, and political arenas of the whole world.

In addressing infectious diseases, the proposed approach is a multidisciplinary approach referred to as a “one health approach”. Early detection and response is of vital importance and the integration of new technological methods is called for. Good laboratory technologies, clinical and epidemiological expertise of of importance in this. Clinicians should be altered to unusual clinical presentations that are suggestive of infectious diseases, as late detection can incur staggering costs to lives and economies.

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*Plenary  
Speeches*

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# PURPOSE DRIVEN EDUCATION

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Nations that developed rapidly had their population working in unison to achieve economic prosperity. The most important resource of any nation for such economic opulence is the determination and the education skills of its people. People's ability to advance their quality of life, depends on their skills to practice their knowledge and not just knowledge. Purpose Driven Education focuses on the development of these skills. There are many elements that contribute to the development of the purpose driven education culture. Empowering the concept of learning,

adopting a horizontal or broad-based curriculum, early introduction to practice of research, training for innovation and entrepreneurship are among major contributors. Research has shown that these elements significantly contribute to development of a workforce which would help advance the economic progress of a nation and in advancing its quality of life.

# THE FUTURE OF RESOLVING THE HUMAN ELEPHANT CONFLICT (HEC) THROUGH HUMAN ELEPHANT CO-EXISTENCE (HEC)

**Dr SW Kotagama**

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The current situation of the Human Elephant Conflict (HEC) require a deeper inquiry to ensure its prevention and mitigation. Some very fundamental facts are being currently ignored in the pursuit of trying to resolve the problem. The actions taken so far at an exorbitant cost with no regard to the large volume of scientific information generated, appear not to be bringing a resolution but increasing the conflict. A few back-ground information will make this clear.

- As part of the strategy to curtail the movement of elephants close to 2000km of electric fences have been erected. What is the cost of this? the cost of erection of 01 km of fencing is at the lower end Rs 500,000.00 per km. Accordingly for the 2000 km of fencing we have spent Rs 1,000,000,000.00 or one billion.
- Despite the erection of 2000km of fencing the HEC intensity has not reduced over the past years. In fact the events have become more riotous and unmanageable.
- Further to the fencing troublesome elephants have been translocated, despite radiocollared scientific information clearly show that it is not a successful strategy. In fact, it has resulted in the transfer of the problem to new areas, death of animals and or return to original location.
- The other strategy of large scale drives have also, on post drive inquiry and study shown that none of the drives conducted in the recent years since monitoring have got rid of the problem. Once again it has clearly shown an increase.
- The overall cost of these action in monetary terms though diffused, collectively would easily come close to Rs 2 billion over the last five years. Not taking in account the maintenance cost of fences, compensation and social costs.

- The Department of Wild Conservation (DWC) strategy to confine elephants to PA system has resulted in, many places bifurcating the elephant populations thus exacerbating the problem.
- It is a known fact of the distribution of elephants in the country that around 70% of the elephant population is found outside the DWC PA system. Yet much of the 2000 km fences are along the DWC Pennsylvanias, thus keeping out much of the animals to continue to raid and cause havoc.
- The fenced area ecological capacities does not equate with the scientific evidence of elephant densities in diverse habitats. It is know from the science that good tall forests harbour an elephant density of less than 01 per sq km. The main reason why the elephants are outside the DWC PA system is this. the forest reserves been tampered have much richer secondary vegetation in which the density is around 2-4 per sq km.
- The evidence of malnourished starved elephants within fenced areas has been recorded and substantiated in the recent studies of the South East and Udawalwe populations. This is again exacerbated by driving some animals from outside in to PAs, increasing the density and thus resulting in habitat destruction and starvation.

All the factors are clearly indicative of that, the present strategy are not working either in the interest of elephants or humans. In the light of the following background, inquiry into the information available of the elephant ecology, background to the conflict, analysis of present strategies, will be discussed. Concluding with some radical future directions if the country with the highest human density, largest conservation land scape and the highest wild elephant density is to remain without CONFLICT in COEXISTENCE.

# EMERGING INFECTIOUS DISEASES: THE NEGLECTED DIMENSION OF GLOBAL SECURITY

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Novel emerging infectious diseases continue to arise in this 21st Century, posing unexpected threats. Recent examples include SARS, influenza, Ebola and most recently, Zika. Such epidemics often spread with great rapidity and across geographical boundaries leading to major social, economic, and political, as well as human or animal health impact. Many of these epidemics arise from viruses in domestic animals or wildlife. Recent changes in human behavior and travel, food production systems, deforestation and environmental change facilitate such disease emergence. Understanding the drivers of such events may allow measures for “containment at source”, i.e. generic measures for risk reduction. These include improved infection control measures in hospitals and evidence based measures for reducing zoonotic transmission. Enhancing surveillance and response systems for infectious diseases are crucial for early detection and containment. The delayed recognition of the Ebola outbreak in Guinea in 2013 resulted in the outbreak spreading across borders leading to >28,000 human cases and >11,000 deaths with cases being exported to multiple

continents. In 2015, one returning traveler initiated an outbreak of MERS in South Korea that led to >186 human cases and a negative economic impact of approx. USD 1 billion. Recent outbreaks of dengue and influenza in Sri Lanka illustrate the ongoing impact of endemic infectious diseases. The “Commission on a Global Health Risk Framework for the Future” hosted by the US National Academy of Medicine estimates the annualized expected economic loss from potential pandemics is >USD 60 billion. Given the complex and multifactorial factors contributing to such events, an integrated, multidisciplinary approach is needed in our response. The concept of “One Health” envisages a multidisciplinary, holistic and integrated approach to optimize health of humans, animals and the environment. This requires the collaboration of expertise in public health, animal health, environmental science and the seamless integration of laboratory, epidemiology, behavioral, and anthropological expertise.

# WARS BETWEEN STATES AND GLOBAL HEALTH: THE SDG THE INTERNATIONAL COMMUNITY CHOSE TO IGNORE

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Since the beginning of the Second World War (1939), wars between countries have killed and injured above a billion. Some wars decimated millions within minutes (e.g. nuclear bombs in Hiroshima and Nagasaki), and others continue to destroy the very fabric of societies (e.g. Iraq). They have displaced millions and permanently crippled billions, mentally and physically. Furthermore, they destroy natural ecologies, contaminate environments, and contribute to climate change. In summary, wars between states have the ability to destroy all the development agendas listed in the UN's Sustainable Development Goals-2015, overnight. The SDGs offered a historic opportunity for individuals,

civil society groups, nation-states and humanity to demand and pledge towards a globe free from wars and continue its march towards global peace. Though global peace is a prerequisite for any form of development, the SDGs ignore it and instead focus on conflicts, violence and human rights within countries. This gives inadequate attention to wars between countries and global peace. We need a fresh goal for the globe. This may be the last chance for the millions of innocent victims destined to die from wars in future...



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*Technical  
Sessions*

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(ORAL AND POSTER PRESENTATIONS)

# A STUDY ON THE PREVALENCE OF HIGH CHOLESTEROL AMONG AIRCREW MEMBERS OF SRI LANKA AIR FORCE

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**Abstract** - Flying involves a complex interaction between the aviator and a sophisticated machine in a highly challenging environment. Thus the physical fitness of aircrew should be maintained at the highest level when flying an aircraft. Physical health of the aviators can be challenged by group of diseases known as noncommunicable diseases which is highly prevalent in Sri Lanka. The focus of this research is to study the occurrence of dyslipidemia and associated risk factors among the air crew members of Sri Lanka Air Force (SLAF). Data collection was carried out by self-administered questionnaire among 100 volunteered air crew members and using the records available on their medical folders at their consent. Study finds that among the population under study, 38% having high total cholesterol, 70% having high LDL levels and 16% having low HDL levels. Prevalence of high LDL level is found to be at an alarming high level in this sample and the only statistically proven contributing risk factor ( $P=0.048$ ) was deduced to be the consumption of food with high lipid content. The results of this research will be a useful for planning and implementation of relevant programs in SLAF in maintaining the proper health conditions in air crew members.

**Keywords** - Dyslipidemia, High Cholesterol, Air Crew, SLAF

## I. INTRODUCTION

Flying is a highly skilled job involving complex interactions between the aviator and the sophisticated machine in a strange environment. It is this imperative threat that physical and mental fitness of aircrew be maintained at the

highest level for flying modern combat aircraft.

Stringent Aircrew medical examination (ACME) of Aircrew is mending to identify potential causes of medical incapacitations or disability with bearing on physical fitness. Medical disabilities in an Aircrew may lead to temporary unfitness from flying duties or permanent cancelation of flying license. High challenge is persistence for group of diseases known as noncommunicable diseases (NCD) which in case of an air crew may affect flying fitness. High cholesterol thus has the potential to not only impairing the performances of air crew and jeopardize the flight safety but also compromise there employability.

Dyslipidemia is a primary, major risk factor for Coronary Artery Diseases (CAD) and may even be a prerequisite for CAD, occurring before other major risk factors come into play (Turner et al., 1998). In Sri Lankan population Dyslipidemia was the most prevalent (87.3%) risk factor as independent risk factors for the coronary artery disease (CAD) disease (Herath et al., 2010)

The prevalence of dyslipidemias varies according to the ethnic, socioeconomic, and cultural characteristics of distinct population groups due to ethnicity factors, working environment, geography, and lifestyle (Ujcic-Voortman et al., 2010).

The prevalence of hypercholesterolemia ( $>5.2\text{mmol/L}$ ), Low Density Lipid (LDL) ( $>3.4\text{mmol/L}$ ), low High Density Lipid (HDL) ( $<1.0\text{mmol/L}$ ) and high Triglyceride (TG) ( $1.7\text{mmol/L}$ ) were 53.6%, 24.7%, 53.1 %, 22.7% respectively in Sri Lankan population according to research data in 2010 among nationally representative sample of 5000 subjects over 18 years by a multistage random cluster sampling technique. The means (SD) of

TC, HDLC, LDLC and TG were 5.35(1.13), 1.21(0.28), 3.51(0.97) and 1.38(0.75) mmol/l. It shows a high prevalence of Dyslipidemia among Sri Lankan adults (Herath et al., 2010).

Indian Council of Medical Research–India Diabetes (ICMR-INDIAB) study which covered a population of 213 million people using stratified multistage sampling design found that 13.9% had Hypercholesterolemia, 29.5% had Hypertriglyceridemia, 72.3% had low HDL-C, 11.8% had high LDL-C levels and 79% had abnormalities in one of the lipid parameters (Joshi et al, 2014).

South Asians around the globe have the highest rates of CAD, with a higher risk at younger ages and are accompanied by low or similar rates of major traditional risk factors (Enas et al., 2007).

Among South Asian population Mean serum cholesterol (180-200 mg dl<sup>-1</sup>), obesity (5-8%) and dietary fat intake are paradoxically lower and do not explain the cause of increased susceptibility to CAD and Diabetes. The force of lipid-related risk factors and of higher body mass index appears to be greater in people of South Asian origin owing to the presence of central obesity, insulin resistance, low high-density lipoprotein cholesterol, higher lipoprotein(a), decreased beta-cell function, in-utero under nutrition, deficiency of antioxidants and higher levels of angiotensin-converting enzyme.(Singh et al., 2001).

According to American heart association 31.7% in the United States have high LDL and 12.9% are having high TC. Less than half (48.1%) of adults with high LDL cholesterol are getting treatment to lower their levels (Mozaffarian et al., 2014).

Because of their special working environment, Dyslipidemia is more harmful to aviators than to people in the general population (Davenport et al., 2015) . Dyslipidemia may leads to aero related diseases, such as vertigo, syncope, and flight illusion, which could be dangerous during flight. Indeed, nearly half of grounded aviators are grounded due to cardiovascular disease, a condition which correlates with Dyslipidemia (Liu et al, 2011).

Endocrinology and Diabetes Mellitus occupy a significant prevalence in clinical aviation medicine, leading to flying restrictions in large proportion of referred patients. (Gifford et al., 2015).

A retrospective cohort analysis of all military aircrew, airspace managers and rear crew aged over 59 years referred for Enhanced Cardiovascular Screening (ECS) programme, Cardiovascular risks identified included: smoking (active 3.9%, ex- smoker 16.7%), Hypertension (34.5%), Hypercholesterolemia (23%), atrial fibrillation (1.3%) and a family history of acute coronary syndrome (10.3%). Military aircrews are often placed under considerable occupational stress and require a high level of physical fitness (Chamley et al., 2006).

A research done among 305 Chinese aviators those who were selected randomly and followed up from 2006 to 2011, the prevalence of total Cholesterol(TC), TG, HDL and LDL among this population was 12.13%, 1.3%, 4.43, and 45.9% and it is found that they presented with Dyslipidemia younger than other Chinese populations (Zhao et al., 2014).

## II. METHODOLOGY

### A. Characteristics of the study population

The sample size for the study is 100 subjects from the Aircrew members who have done their 2015 ACME from SLAF Hospital Rathmalana. The sample size was selected in order to obtain data of sizable number of respondents of varying categories with the limited availability of resources, would not overburden the researcher.

### B. Sample design and procedure

Systematic sampling – 100 Aircrew members who are posted and attached to Rathmalana Base for year 2015 was taken as the sample.

### C. Study instrument

Pretested self-administered questionnaire developed with the expert's opinion, in order to study the prevalence of Dyslipidemia and associated risk factors among the Aircrew members of Sri Lanka Air Force. The second part of the questionnaire is filled by the data available in Aircrew medical folder of each personnel.

The questionnaire developed according to SLAF Health policy on Aircrew Medical Examination, American Heart Association guidelines on Dyslipidemia, Sri Lankan Dietary Guidelines by the Ministry of Health and 10 Perceived Stress Scale on Stress. It is prepared by the investigators considering the objectives of the study. It also pre-test on ten randomly selected air crew members to verify whether they understand the questions and confirm

whether that would be suitable to collect data.

**D. Ethical consideration**

Permission acquired from the Commanding Officer of SLAF Hospital Rathmalana to refer the Air crew folders at ACME of RMA and relevant Commanding Officers of the Helitours, No 4 Squadron, No 6 Squadron and No 8 Squadron to administer the questionnaire among the Aircrew members.

Informed verbal consent was obtained from all the participants before giving the questionnaire. Names or Squadron were not included in the questionnaire, only the service number asked to trace the Aircrew Medical Folder. Voluntary participation and autonomy to give consent or to refuse participation in the study or to withdraw from the study at any time despite consenting to take part earlier respected.

**E. Inclusion and exclusion criteria**

Aircrew members who were posted and attached to Rathmalana Base for the year 2015 used as inclusion criteria.

Aircrew members who were on foreign mission, on local or foreign training, who were holding an administrative appointment without flying at the time of administering the research questionnaire and all the cabin attendants and stewards were excluded from this research.

**F. Data analysis**

Data were processed and analysed by using IBM SPSS Statistics 20.

**III. RESULTS**

**A. Sociodemographic characteristic**

The research was carried out by obtaining data from 100 Aircrew subjects covering almost all the Aircrew profess

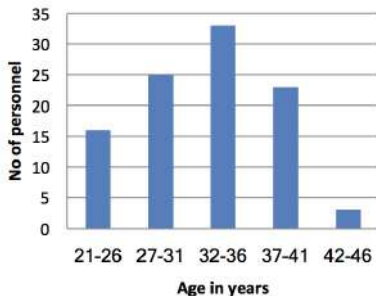


Figure 1. Age distribution of the sample



Figure 2. Rank distribution of the sample

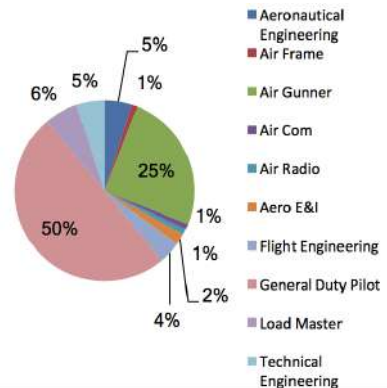


Figure 2. Branch/Trade distribution of the sample

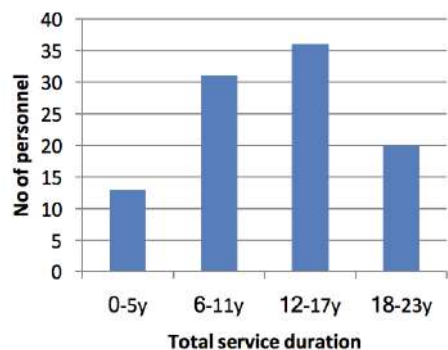


Figure 3. Distribution according to the service duration

**B. Known risk factors for Dyslipidemia**

The table 1 shows statistical analysis between known risk factors and total cholesterol level. The only statistically proven known risk factor for Dyslipidemia in this sample is high intake of diet with high fat levels. It shows by this research that there are relationship between smoking,

alcohol consumption, positive Family history (FHx) of non-communicable disease and high Body Mass Index (BMI) as risk factors for Dyslipidemia in this population but it is not statistically proven in this sample.

Eventhough high intake of egg yolk and Stress level are high in this sample, it is not correlating as a risk factor for Dyslipidemia in this population. The physical activities are also not correlating as a risk factor for Dyslipidemia in

**Table 1. Statistical analysis between known risk factors and total cholesterol (TC) level of the lipid profile**

Known Risk factor		TC<200mg/dl	TC>200mg/dl	Significance
Smoking	Smoker(40)	24(60.0%)	16(40.0%)	$\chi^2 = 0.113, df = 1, p = 0.737$
	Nonsmoker(60)	38(63.3%)	22(36.7%)	
Alcohol	Alcoholic(65)	38(58.5%)	27(41.5%)	$\chi^2 = 0.987, df = 1, p = 0.320$
	Non-Alcoholic(35)	24(68.6%)	11(31.4%)	
Family history	No FHx of NCD(69)	47(68.1%)	22(31.9%)	$\chi^2 = 3.534, df = 1, p = .060$
	FHx of NCD(31)	15(48.4%)	16(51.6%)	
BMI (According to AFM: MED 101,201)	Normal BMI(92)	58(63.0%)	34(37.0%)	Fisher's exact test- Exact Sig. (2-sided) 0.474, (1-sided)0.356
	High BMI(8)	4(50.0%)	4(50.0%)	
Physical exercise	Exercise adequate(79)	46(58.2%)	33(41.8%)	$\chi^2 = 2.272, df = 1, p = 0.132$
	Exercise inadequate(21)	16(76.2%)	5(23.8%)	
Stress	No significant stress(56)	35(62.5%)	21(37.5%)	$\chi^2 = 0.014, df = 1, p = 0.907$
	Significant stress(44)	27(61.36%)	17(38.64%)	
Dietary intake of fat	High fat intake(73)	41(56.2%)	32(43.8%)	$\chi^2 = 3.908, df = 1, p = 0.048$
	Normal fat intake(37)	21(77.8%)	6(22.2%)	
	>3 eggs per week(43)	27(62.8%)	16(37.2%)	$\chi^2 = 0.020, df = 1, p = 0.887$
	<3 eggs per week(57)	35(61.4%)	22(38.6%)	
	Sausages >3 meals per week(24)	8(33.3%)	16(66.7%)	$\chi^2 = 11.015, df = 1, p = 0.001$
	sausages < 3 meals per week(66)	54(71.1%)	22(28.9%)	
	Pork >3 meals per week(30)	15(50.0%)	15(50.0%)	$\chi^2 = 2.619, df = 1, P = 0.106$
	Pork < 3 meals per week(70)	47(67.1%)	23(32.9%)	

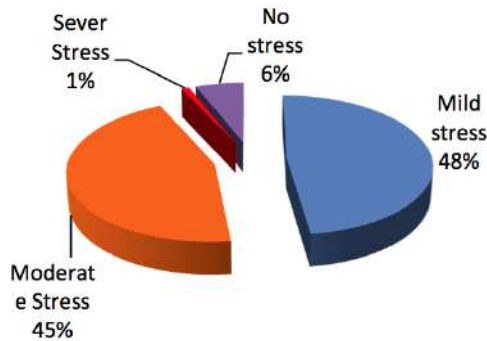


Figure 4. Stress level of the sample

In this sample of Aircrew 94% of the subjects are having Stress according to 10 Perceived Stress Scale (PSS). Out of them also 45% of the subjects are having moderate stress(Figure 1). No and Mild stress categorized as no significant stress and moderate & sever stress as significant stress. Among Pilots 98% of the subjects are having Stress. Eventhough stress is a known risk factor for Dyslipidemia it is not statistically proven nor correlated in this sample.

C. Analysis of the lipid profile

The prevalence rates of Dyslipidemia within this study population are, 38% having high total cholesterol, 70% having high LDL levels and 16% having low HDL levels (High Blood Cholesterol ATP III Guidelines n.d.). According to research data mean values of LDL (70%) and HDL (16%) level are not in the optimal levels of the sample(Table 2) .Six percent of the personnel are on treatment for Dyslipidemia and all of them are from GDP

Table 2. Mean values of the lipid profiles of the sample

	TC	HDL	TG	LDL
Mean(mg/dl)	191.41	45.41	104.06	118.21
Optimal level(mg/dl)	<200	>40	<150	<100

branch

IV. DISCUSSION

Prevalence of high LDL level is high in this target population when we compare it with Sri Lankan general population data (Herath et al., 2010), eventhough this our study population is young healthy adults. The prevalence of high TC and low HDL levels are lower than Sri Lankan general population and this may be due to this our population is selected healthy younger population when compared with Sri Lankan general population data. When these figures compared with Indian (Joshi et al., 2014), Chinese(Qi et al., 2015) and American general population data (Mozaffarian et al., 2014) Prevalance of high TC and LDL both are higher than those general populations .

Also our population prevalence rates of TC higher than the Royal Air Force military Aircrew, Airspace managers and rear crew aged over 59 years (Chamley et al., 2006) and Chinese aviators (Zhao et al., 2014).

The mean TC, LDL, HDL and TG level of this population are lower than Sri Lankan general population statistics (Herath et al., 2010), this may due to target population is younger than general population.

The prevalence of smoking and alcohol consumption is higher than general population of the country in 2015 (STEPS Survey Sri Lanka 2015). The only statistically proven known risk factor for Dyslipidemia in this sample is high intake of diet with high fat levels and other known risk factors are not statistically proven in this sample

This observation may be explained by the inadequate history data collected in the questionnaire, inadequate sampling and South Asian paradox of dyslipidemia risk factors (Singh et al., 2001, Enas et al., 2007).

In this sample of Aircrew are having high level of Stress. Aircrew needs some stress (eustress) for their optimum performance, but this is an alarming figure and a flight safety issue.

V. RECOMMENDATIONS

This research is a dire need of the air crew medical section in SLAF as it gives an assessment for on- going effort to control present known risk factors for Dyslipidemia. Hence the result of this research will be a useful for planning and implementation of relevant programs in ACME in SLAF. Though the LDL value indicates clear association with Dyslipidemia, the Aircrew guild lines of SLAF only considered Total Cholesterol value to analyse Aircrew personal for Dyslipidemia during ACME. Therefore it is

recommended to be considered LDL value also with TC during ACME to identify Dyslipidemia.

It is recommended to use Framingham Risk Score to analyse and to identify CVD risk of Dyslipidemia rather than considering one factor of TC or two factors of TC and LDL value.

Dietary high cholesterol level is a high risk factor for Dyslipidemia and it is statically proven by the research. Hence it is recommended to further research by giving validated food frequency questionnaire to clearly identify the food which causes Dyslipidemia in SLAF aircrew.

Research statistics indicate that stress levels of Pilots are high, thus it is recommended to further research on stress level of the pilots as it is an aviation safety issue. Further to identify the level of eustress and to maintain that level to get maximum output.

#### ACKNOWLEDGEMENT

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# DENTAL FLUOROSIS, DRINKING WATER AND PARTICIPANT PERSPECTIVES: A CROSS-SECTIONAL STUDY AMONG STUDENTS OF A NATIONAL SCHOOL IN ANURADHAPURA

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**Abstract** - Dental fluorosis is caused by excessive fluoride intake mainly via drinking water during the development stage of teeth. Anuradhapura is a region where fluoride levels in drinking water is high. Thambuttegama divisional secretariat of Anuradhapura is considered to be one of the hotspots for high fluoride concentration. The latest available study at Anuradhapura (2004) revealed a prevalence of 90% for very mild to severe form of dental fluorosis. This study aims at finding knowledge, attitude and prevalence of dental fluorosis among students of a National School in Thambuttegama. A descriptive cross sectional study was performed using a self-administered questionnaire at National Schools of Thambuttegama. Dean's index was used to rate severity of dental fluorosis. Participation rate was good (83% - 248/300). Most were females (53%), 12 years old (44%) and from Thalawa division (54%). Mean age of participants was  $12.8 \pm 0.76$  years. Majority of the participants didn't know about dental fluorosis (64%). Parents were the commonest source of knowledge on dental fluorosis (32%). Most of the participants (73%) were satisfied with the appearance of their teeth. 09% of participants have never visited a dentist. According to the Dean's index 37.5% belonged to

very mild to severe form of dental fluorosis. Well water was used by most (44%). Among the well water users, 41% (45/109) had very mild to severe form of dental fluorosis in comparison to 35% (48/139) in other water users. There was no significant difference ( $X^2 = 1.1884$ ;  $P = 0.28$ ) between the two groups. Prevalence of very mild to severe form of dental fluorosis is still high among the school children of Thambuttegama. However their knowledge on dental fluorosis seems to be poor.

**Keywords** - Dental fluorosis, Dean's index, Drinking water, School children

## I. INTRODUCTION

According to World Health Organization (WHO), "Ingestion of excess fluoride, most commonly in drinking-water, can cause fluorosis which affects the teeth and bones. Moderate amounts lead to dental effects, but long-term ingestion of large amounts can lead to potentially severe skeletal problems" (WHO 2001). It has been recognized that fluoride has both favourable effects (Ten Cate 1990) (promoting mineral deposition, inhibiting



mineral dissolution and preventing dental caries) and non-favourable effects such as dental fluorosis (WHO 2001). Dental fluorosis is caused by excessive intake of fluoride via drinking water during the development of the teeth, usually from birth to nearly 6 years of age (WHO 2001). This condition affects children and it is characterized by white discoloured areas of teeth enamel. When the condition is severe teeth become pitted and stained (WHO 2010).

A fluoride concentration of 0.8 - 1.0 mg/l in drinking water has shown to produce dental health benefits (WHO 1994; Petersen & Lennon 2004). The WHO recommended level of fluoride in drinking water is 1.5 mg/l (WHO 2004). Concentrations of fluoride in the range of 1.5-4 mg/l result in dental fluorosis (Mohapatra et al. 2009). High fluoride intake can also result due to consumption of tea leaves which have high levels of fluoride (WHO 2002; WHO 2006). Excessive intake of fluoride has led to millions of cases in endemic areas around the world (WHO 2002).

Several studies have revealed the relation between fluoride content in water and dental fluorosis. A study was done to determine the prevalence and severity of dental fluorosis in young children of Newcastle (a fluoridated area) and Northumberland (a fluoride deficient) (Tabari et al. 2000). The prevalence of fluorosis was 54% and 23% in fluoridated area and fluoride deficient area respectively. Another research conducted in India revealed a prevalence of 59% for dental fluorosis in high fluoride area in comparison to 39% in normal fluoride area (Kotecha et al. 2012).

In dry zones high concentration of fluoride is seen in both dug and deep wells (Dissanayake 1991). Nearly 75% of the population in Sri Lanka, who live in rural areas, obtain its drinking water from the ground sources (Dissanayake 1996). The daily water consumption by an individual is much higher in Sri Lanka as it is located in the humid tropical zone (Dissanayake 1996). Therefore the incidence of dental fluorosis in dry zones of Sri Lanka is high. It results in psychological problems among school children of the low income rural areas of the dry zone (Dissanayake 1996).

Anuradhapura district belongs to the dry zone of Sri Lanka, where a maximum fluoride level of 13.7 mg/l in drinking water was recorded (Chandrajith et al. 2012). About 85% of the population in this area obtain their drinking water from shallow or deep ground water (Chandrajith et al. 2012). 19 out of 22 divisions of Anuradhapura district have been identified as containing high levels of fluoride. Thambuttegama, one of those divisions, had 1.6% of its

wells with fluoride levels of 4-10 mg/l. 31.4% of the wells had 2-4 mg/l fluoride levels. Therefore Thambuttegama can be considered as one of the hotspots for high fluoride concentration (Chandrajith et al. 2012).

A study in 1999 among 12-14 years old children of Eppawela division of Anuradhapura has revealed 97% prevalence of dental fluorosis (Nanayakkara et al. 1999). A similar study was performed to estimate the prevalence of dental fluorosis in Anuradhapura district in 2004 (Tennakoon 2004). According to Dean's index very mild or greater dental fluorosis was seen in 89.8% of those participants. 33.2% of them needed treatment (Tennakoon 2004). Treatment for dental fluorosis ranges from a conservative bleaching management to an extensive full crown restorations (Sherwood 2010).

Children are the most affected with dental fluorosis because their teeth are in its developing stage. It is important to determine the prevalence of dental fluorosis among them. To the best of our knowledge it has been nearly 12 years from the last estimation of the prevalence of dental fluorosis in Anuradhapura district. The aim of this study was to determine the knowledge, attitude and prevalence of dental fluorosis among 12 – 14 year old students of the National School in Thambuttegama, Sri Lanka.

## II. METHODOLOGY AND EXPERIMENTAL DESIGN

### A. Study setting

A descriptive cross sectional study was performed from July to August 2016 in Anuradhapura, the largest district by surface area in Sri Lanka. Total estimated mid-year population of the district is 905,000 (DCS 2016). Main employment (55%) of the district is agriculture (DCS 2014). Household Income and Expenditure Survey of 2012/2013 revealed the district's poverty head count index as 7.6%, whereas the country's value is 6.7% (DCS 2015). Thambuttegama divisional secretariat of Anuradhapura showed an estimated head count index of 7.38% with the number of poor people being 3042 (DCS 2015). Anuradhapura Siddhartha School is the only national school located in Thambuttegama which was selected for our study.

**B. Sampling method and study instrument**

All 12-14 year old students of the National School of Thambuttegama, who gave informed written consent, were included. A self-administered questionnaire was used to collect demographic data and information on knowledge, attitude and risk factors of dental fluorosis. The questions were adapted from previous studies conducted in Quetta, Pakistan (Sami et al. 2015) and Kilimanjaro Region, Tanzania (Roman 2010).

**C. Data collection, analysis and description of data**

Institutional permission was obtained from the Director, Thambuttegama zonal education office and the Principal of the relevant school. Participants were recruited on the last day of their end of term exam. Both parental consent and assent was obtained. Participants were allowed to discuss the project with their family or friends before making a decision on participation. Following the administration of the questionnaire, teeth were examined under natural light using the criteria for Dean’s index (Dean HT 1934). According to Dean’s index dental fluorosis was classified under six categories. They were; normal, questionable, very mild, mild, moderate and severe. Data was analysed using Microsoft excel. Descriptive statistics were used to describe the data.

**III. RESULTS**

Two hundred and forty eight students (83%) out of three hundred participated in the study. Out of which students from grade-7 were 44 %, grade-8 were 36% and grade-9 were 20%. Majority of the participants were females (53%), 12 years old (44%) and from Thalawa division (54%). The mean age of the participants was 12.8 ± 0.76 years.

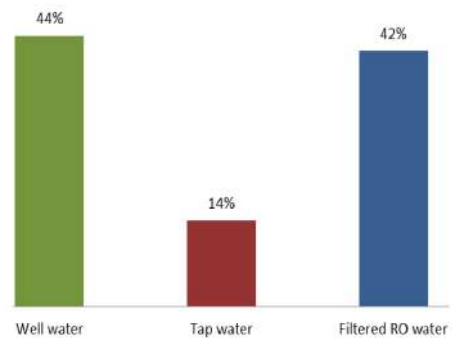
**A. Knowledge and awareness**

More than 75% of participants did not know the following: the typical appearance of dental fluorosis, that fluoride in drinking water helps to prevent tooth decay, that too much fluoride in drinking water can cause mottled teeth and that tea has high fluoride levels. However more than 50% of participants did know that fluoride can prevent tooth decay

Awareness on dental fluorosis was poor. 64% participants didn’t know about dental fluorosis. Most of the participants who knew about dental fluorosis, acquired knowledge from parents (32%), and rest were from the following sources: teachers (30%), newspapers (20%), television (13%) and internet (5%).

**B. Attitudes and possible risk factors**

Most of the participants used well water (44%) as their water source (Figure 1) and had drunk one to two cups (51%) of tea per day. Majority of the participants (73%) were satisfied with the appearance of their teeth. They thought that brown teeth affect less on their daily activities (Table 1). 9% participants never visited their dentist. 5% of the participants have attempted to remove the brownish discoloration of their teeth by a dentist, 3% by scrubbing teeth with charcoal, 3% by scrubbing teeth with sand and 1% by grinding teeth with stone.



*Figure 2. Percentage use of different sources of drinking water, Thambuttegama 2016*

**C. Prevalence of dental fluorosis**

According to the dean’s index 35.9% subjects were normal. 26.6%, 13.7%, 10.1%, 9.7% and 4% subjects belonged to questionable, very mild, mild, moderate and severe categories respectively. Those who found to have moderate or severe dental fluorosis were offered a referral to the nearest dental clinic, yet only ten participants agreed to proceed.

**D. Drinking water source versus dental fluorosis**

Out of those who had well water as their main source of drinking water, 41% (45/109) had very mild to severe form of dental fluorosis. Out of those who had other water sources as their main source of drinking water, 35% (48/139) had very mild to severe form of dental fluorosis. There was no significant difference between the main source of drinking water and the severity of dental fluorosis ( $X^2 = 1.1884$ ;  $P = 0.28$ ).

## IV. DISCUSSION

Participation for the study was satisfactory (83%). Previous Sri Lankan published data on knowledge and attitude of dental fluorosis was lacking. However in a similar study in Pakistan (Sami et al. 2015) 55.6% of children agreed that consumption of too much fluoride can cause dental fluorosis whereas only 40% of our participants agreed on the same. Only 1.4% of children in the Pakistani study agreed that too much fluoride in drinking water can cause mottled teeth whereas our study had 23% (Sami et al. 2015). 4.3% and 23% of the participants of Pakistan and Thambuttegama respectively knew that tea has high fluoride content. Although parents (32%) were the commonest source of information on dental fluorosis in our study, it was the teachers (35%) in Pakistan. According to our study majority (44%) of participants used well water as their water source, while 99.7% participants subjected in Pakistan used tube well water as their water source (Sami et al. 2015). 85.1% of the participants of the study conducted in Tanzania (Roman 2010) agreed that brown teeth is a problem and only 73% of participants of our study agreed on the same. 96.3% of participants in Tanzania agreed that brown teeth need to be treated whereas it was only 71% in our study.

The previous study on prevalence of dental fluorosis in Anuradhapura by Tennakoon T in 2004 revealed that 89.8% of the participants had very mild to severe dental fluorosis (Tennakoon 2004). To the best of our knowledge there was no previous data on the prevalence of dental fluorosis in Thambuttegama division but according to our study, 37.5% belongs to very mild to severe category. This shows a decrease in-comparison to the previous study done in the entire district of Anuradhapura.

Proportion of households using an improved drinking water source in Anuradhapura district has increased from

**Table 1. Participant attitude towards dental fluorosis, Thambuttegama 2016**

Percentage of participants who agreed to the statements on attitude towards brown teeth (%) n=248		Percentage of participants who think that brown teeth affects following daily activities (%) n=248	
Brown teeth is a problem	73	Eating	18
Brown teeth affects smiling	70	Cleaning mouth	09
Brown teeth are difficult to clean	67	Speaking	32
Brown teeth may cause sensitivity	40	Sleeping	04
Brown teeth need to be treated	71	Smiling	54
		School work	11
		Emotion	07
		Social contacts	11

71.7% in 1994 to 95.4% in 2012 (DCS 2012). According to our study 42% of participants used filtered water by reverse osmosis as their drinking water source. This can be a contributing factor for the reduction of very mild to severe form of dental fluorosis in the area of study. There was no significant difference related to the main source of drinking water and the severity of dental fluorosis. Although this seems unexplainable, use of other types of improved drinking water as secondary sources would be a possible reason.

Although the findings of this study were limited to Thambuttegama, Sri Lanka, it has provided useful information to depict the changing pattern of dental fluorosis in this region.

## V. CONCLUSION

Along with the increase in use of improved drinking water, the prevalence of very mild to severe form of dental fluorosis has reduced in the target population. However it is still at 37.5% with a poor knowledge on dental fluorosis among participants. This warrants the need of health education to improve awareness on dental fluorosis.

## VI. DECLARATIONS

### A. Ethical approval and consent to participate

Ethical clearance was obtained from the Ethics Review Committee, Faculty of Medicine and Allied Sciences, Rajarata University of Sri Lanka (ERC/2016/40). Informed written assents were obtained from all the children and informed written consents from their parents.

### B. Competing interests

The authors declare that they have no competing interests.

### C. Funding

This was a self-funded study.

### D. Authors' contributions

All authors participated in designing the study. IJ, DJ, FJ, SK, CK and RK involved in data collection. IJ and DR were involved in analysis of data and all authors were involved in interpretation of data. IJ, DJ, FJ, SK, CK and RK drafted the manuscript. DR critically revised it. All authors read and approved the manuscript.

## E. Availability of data and material

Datasets analyzed during the current study are available from the corresponding author on reasonable request.

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# CLINICAL AUDIT ON EFFECTIVE USAGE OF PARTOGRAM IN OBSTETRIC UNIT-B OF DGH-KALUTHARA FROM 01<sup>ST</sup> OF MARCH TO 31<sup>ST</sup> OF MAY 2016

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WHO recommend partogram for universal use during labour as a necessary tool. Continuous monitoring during labour provides a safe care. Further it prevents adverse outcomes relating to child birth. The tool helps to identify deviations early and intervene timely. Annually a huge sum of money is spent on maternal health by the government of Sri Lanka to deliver a free health care to the public. The maternal mortality reported to be low despite Sri Lanka been a developing country. Hence, it is the duty and responsibility to keep the statistics further low and maintain excellent quality of care with the available resources.

Since partogram can detect obstructed labour early, it helps to reduce maternal deaths by preventing uterine rupture, post partum haemorrhage and puerperal infections. Perinatal mortality reduces when traumatic deliveries are less. It is appreciate the use of the tool as it is simple, inexpensive and freely available. The goal of this audit is to assess the effective use of partogram in the local setting. A descriptive study was conducted in obstetric unit B of DGH-Kalutara. The total of 571 of deliveries in March, April and May 2016 were selected for the audit. Effective usage of partogram was assessed by executing partograms of relevant BHTs. Data collection and analysis was done by the auditor.

Client information is included in majority of partograms. Position, caput, moulding, cervical dilatation, contraction free interval, duration of contraction and abdominally descent were not marked in the majority and the technical errors noted during marking.

Practical issues in monitoring and documenting of contraction free interval and duration of contraction

should be addressed. Maternal monitoring and second stage foetal monitoring should be encouraged. A proper training programme of National Partogram should be arranged.

**Keywords** - national partogram of Sri Lanka, labour management, clinical audit

## I. INTRODUCTION

A partogram is a composite graphical record of events of labour (maternal and fetal) entered against time on a single sheet of paper. Relevant measurements might include statistics such as cervical dilation, fetal heart rate, duration of labour and vital signs.

National Partogram of Sri Lanka was newly introduced by Sri Lanka College of Obstetricians and Gynecologists as proposed in 2013.

## II. JUSTIFICATION

Annually a huge sum of money is spent on maternal health by the government Sri Lanka as its free health system and has achieved less number of maternal mortality almost as a developed country. So it is our sole responsibility to stick to our health goals and negotiate obstacles on our way.

As effective usage of partogram can early detect obstructed labour it reduces maternal mortality by preventing ruptured uterus, post partum haemorrhage and puerperal infections. And traumatic delivery can be avoided by reducing perinatal mortality.

Early detection of adverse outcomes by this simple, inexpensive tool should be used effectively.

This study is aimed to explore the effective usage of partogram in obstetric unit B.

### III. METHOD

A descriptive retrospective study was conducted in obstetric unit B of DGH-Kalutara. Total number 571, of deliveries in March, April and May 2016 were selected for the audit. No sampling done. Effective usage of partogram was assessed by executing partograms of relevant BHTs. Natinal partogram of Sri Lanka was used as the study instrument.

Emergency caesarean sections which were directly sent to the operation theatre from obstetric ward and elective caesarean sections were excluded since partogram maintaining is not relevant.

### IV. LIMITATIONS

Following limitations were identified during this audit, Only 82.04% (n=345) of relevant BHTs were found from medical records unit.

Executer bias cannot be excluded since relevant BHTs and partograms were executed by the auditor himself.

Some technical errors (ex; incorrect symbols) in maintaining partogram were not considered since almost all partograms were found to have same technical error.

## V. STUDY FINDINGS

### A. Statistics of the Period of Interest

**Table A1: Statistics of the period of interest in Obs unit BDGH-Kalutara.**

	March 2016	April 2016	May 2016	Total
<b>NVD</b>	112	105	125	342
<b>LR-EM/LSCS</b>	13	30	29	72
<b>Vaccum Deliveries</b>	2	2	1	5
<b>Forceps Deliveries</b>	1	1	1	3
<b>Breech Deliveries</b>	1	0	0	1
<b>Twin Deliveries(Vaginal)</b>	1	1	0	2
<b>IUD(Vaginal Delivery)</b>	1	1	0	2
<b>Total</b>	129	140	154	423
<b>BHT found</b>	120	108	117	345
<b>% of BHT found</b>	93.02%	77.14%	75.97%	82.04%
<b>Total No of Births of Unit B</b>	185	179	207	571

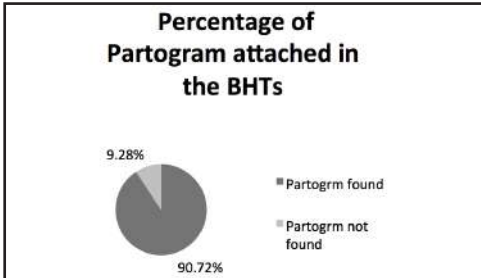
According to ward statics 423 relevant deliveries were occurred during the period of interest and only n=345 (82.04%) BHTs were found due to logistic problems and included for the audit.

### B. Details of Partogram Attached in the BHTs

**Table B1- Details of Partogram attached in the BHTs of relevant deliveries**

	Number	%
<b>Partogram Not Found</b>	32	9.28%
<b>Partogram Found</b>	313	90.72%

**Graph B1- Percentage of Partogram attached in the BHTs of relevant deliveries.**



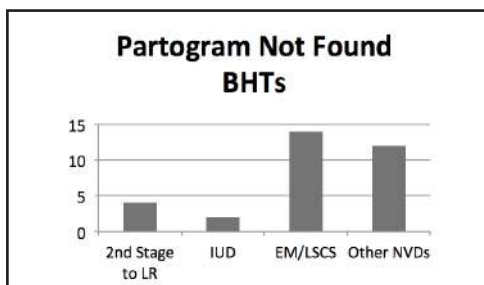
Majority of relevant BHTs were attached with a partogram(90.72%,n=313) and n=32,9.28% of relevant BHTs were found to have without partogram.

Partogram not found BHTs were further described as follows.

**Table B2 - Description of partogram not found BHTs**

Partogram Not Found	Number
2nd Stage admission to LR	4
IUD	2
EM/LSCS	14
Other NVDs	12

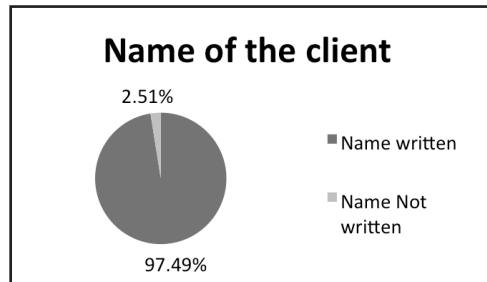
**Graph B2 - Description of partogram not found BHTs**



**C. Information of the Client in the Partogram**

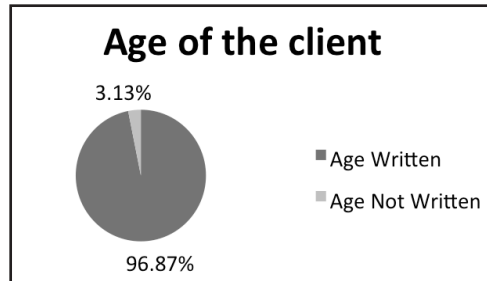
i) Name of the client in the Partogram:

**Graph C1-Name of the client in the Partogram**



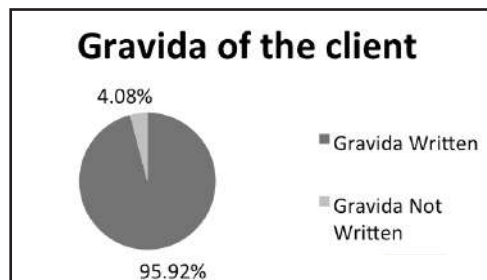
ii) Age of the client in the Partogram:

**Graph C2-Age of the client in the Partogram**



iii) Gravida of the client in the Partogram:

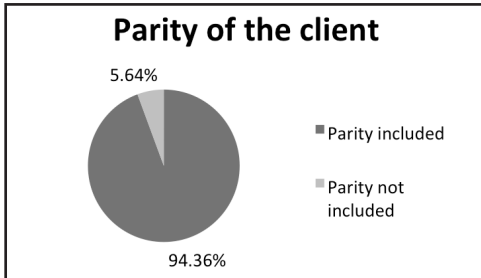
**Graph C3-Gravida of the client in the Partogram**





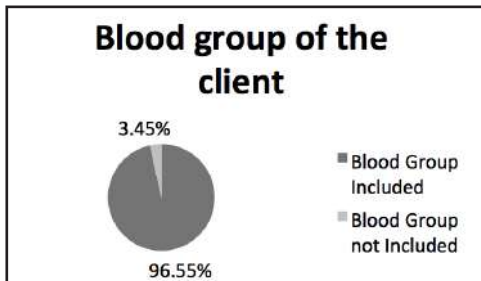
iv) Parity of the client in the Partogram:

**Graph C4-Parity of the client in the Partogram**



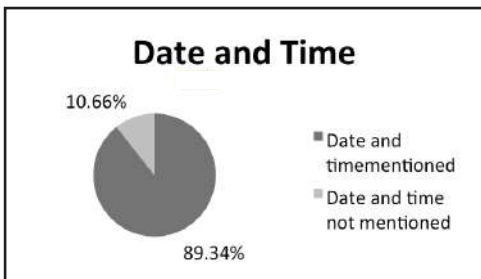
v) Blood group of the client in the Partogram:

**Graph C5- Blood group of the client in the Partogram**



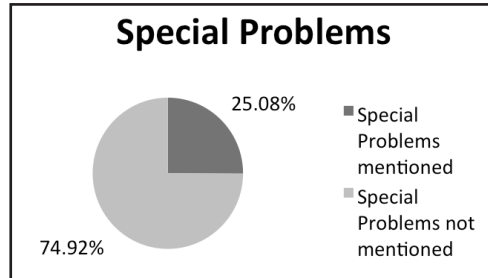
vi) Date and time of onset of Partogram;

**Graph C6- Mentioning of the date and time of onset of partogram**



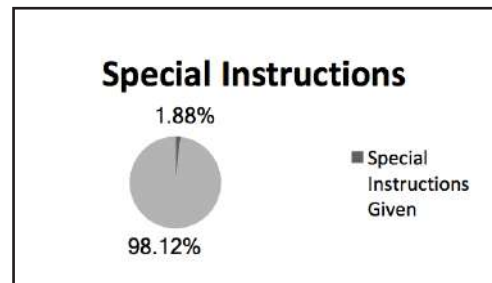
vii) Special problems of client/pregnancy in the partogram;

**Graph C7- Mentioning of special problems of client/pregnancy in the partogram**



viii) Special instructions regarding delivery in the partogram;

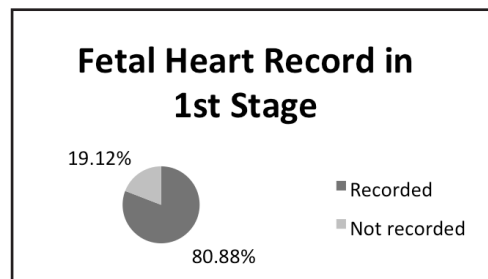
**Graph C8- Mentioning of special instructions regarding the delivery in the partogram**



**D. Monitoring of Foetal Wellbeing During the Labour in the Partogram**

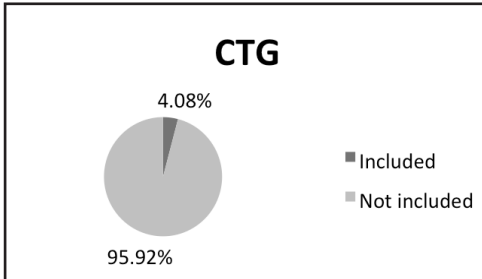
i) Fetal Heart Record in 1st Stage in the partogram;

**Graph D1-Recording of Fetal Heart Rate in 1st Stage in the partogram**



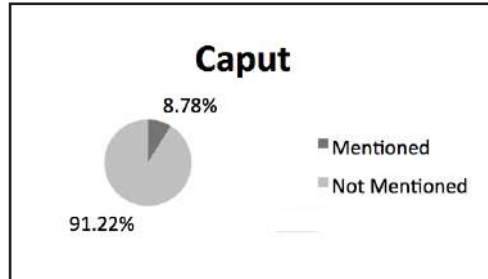
ii} CTG in the partogram;

**Graph D3- Including of CTG in the partogram**



v} Caput in the partogram;

**Graph D5- Mentioning of caput of the foetus in the partogram**



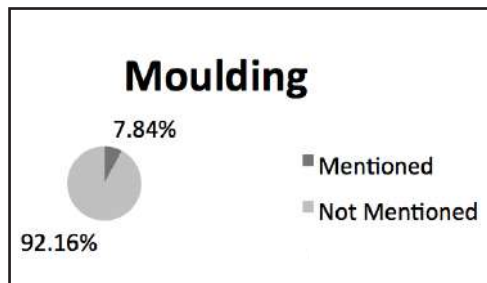
iii} Liquor colour in the partogram;

**Graph D3- Mentioning of liquor colour in the partogram**



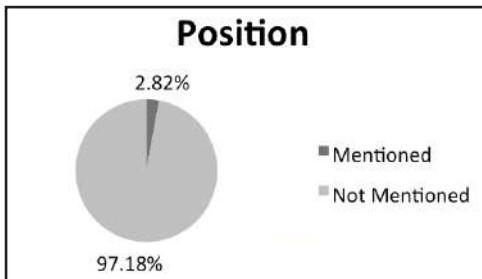
vi} Moulding of the foetal skull in the partogram

**Graph D6- Mentioning of moulding of the foetal skull in the partogram**



iv} Position of the foetus in the partogram;

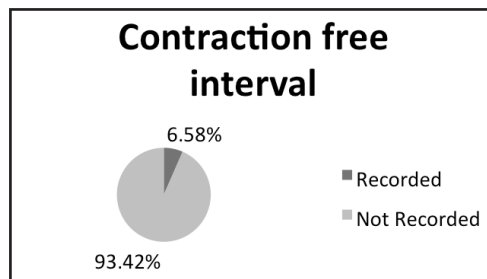
**Graph D4- Mentioning of position of the foetus in the partogram**



E. Progress of the Labour in the Partogram

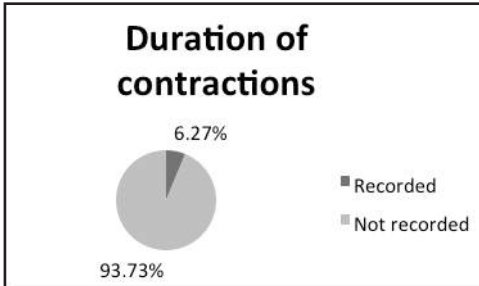
i} Contraction free interval in the partogram;

**Graph E1- Recording of Contraction free interval in the partogram**



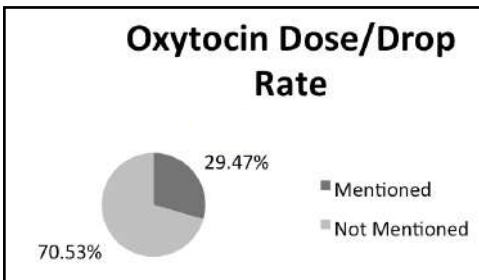
ii} Duration of contractions in the partogram;

**Graph E2- Recording of Duration of contractions in the partogram**



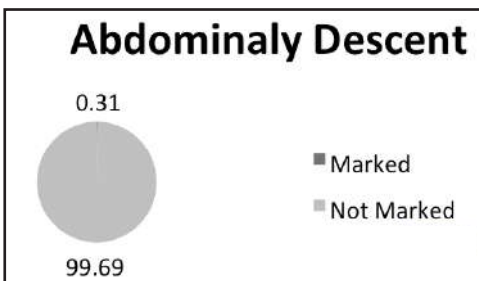
ii} Oxytocin Dose/Drop Rate in the partogram;

**Graph E3- Mentioning of Oxytocin Dose/Drop Rate in the partogram**



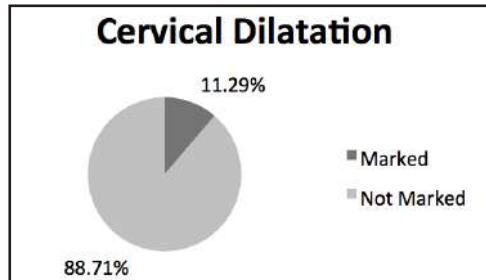
iv} Abdominally Descent in the partogram;

**Graph E4- Marking of Abdominally Descent in the partogram**



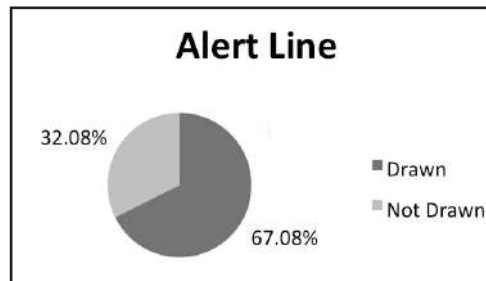
v} Cervical dilatation in the partogram;

**Graph E5- Marking of cervical dilatation in the partogram**



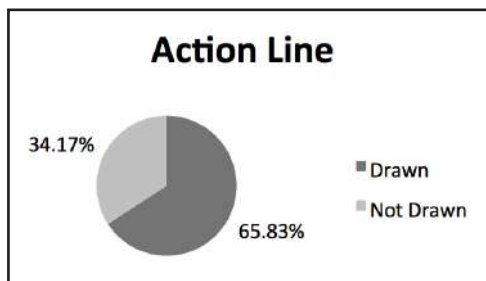
Vi} Alert line in the partogram:

**Graph E6- Drawing of alert line in the partogram**



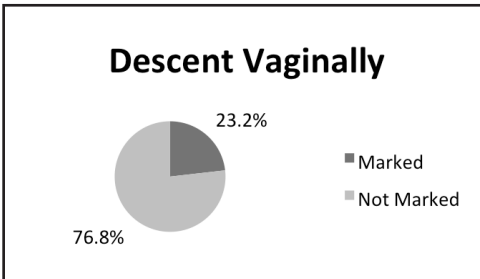
Vii} Action line in the partogram:

**Graph E7- Drawing of action line in the partogram**



Viii} Descent Vaginally in the partogram:

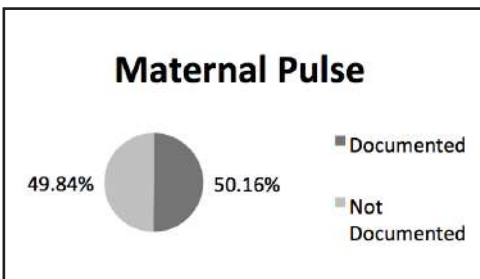
**Graph E8- Descent Vaginally in the partogram**



**F. Monitoring of Maternal Wellbeing During the Labour in the Partogram**

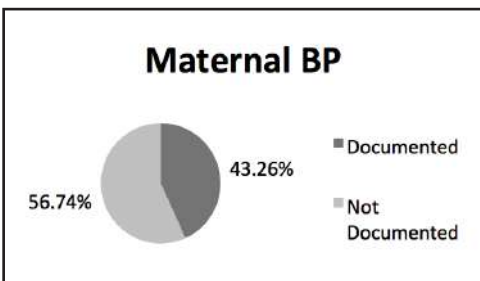
i} Maternal pulse in the partogram:

**Graph F1- Documenting of Maternal pulse during labour in the partogram**



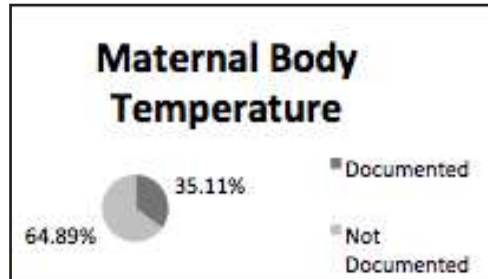
ii} Maternal blood pressure in the partogram:

**Graph F2- Documenting of Maternal blood pressure during labour in the partogram**



iii} Maternal body temperature during labour in the partogram:

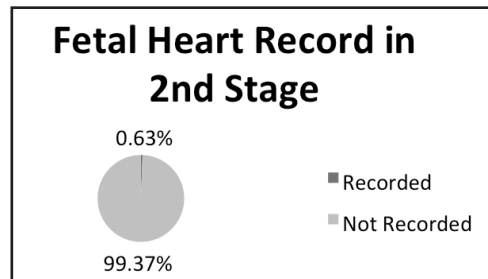
**Graph F3- Documenting of Maternal body temperature during labour in the partogram**



**G. Monitoring of the 2nd stage of Labour**

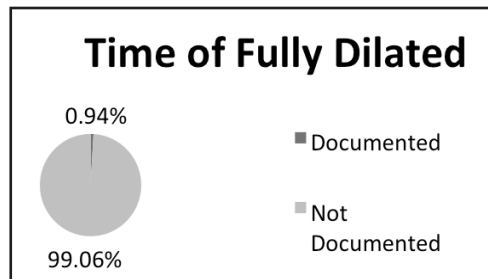
i} Fetal Heart Record in 2nd Stage in the partogram:

**Graph G1- Recording of Fetal Heart Record in 2nd Stage in the partogram**



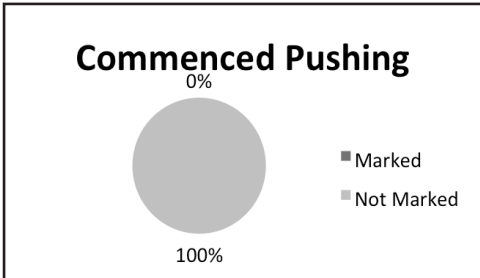
ii} Time of Fully Dilated in the partogram:

**Graph G2- Documenting of Time of Fully Dilated in the partogram**



iii) Marking of Commenced Pushing in the partogram:

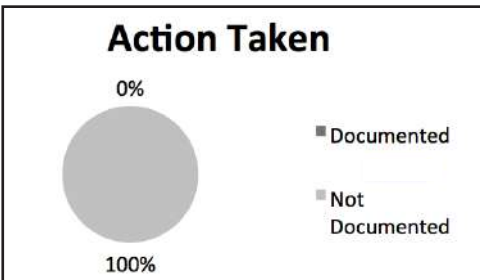
**Graph G3- Marking of Commenced Pushing in the partogram**



H. Action Taken

i) Action taken during labour in the partogram:

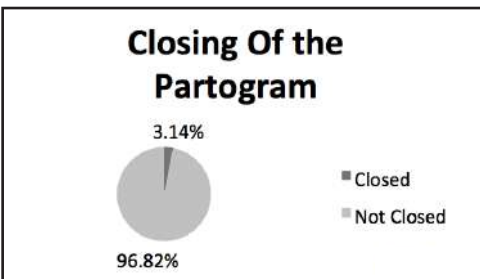
**Graph H1- Documenting of Action taken during labour in the partogram**



I. Closing of the Partogram

i) Closing of the partogram:

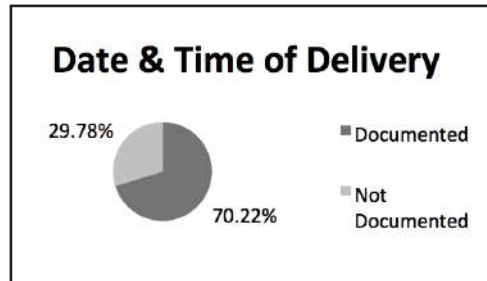
**Graph I1- Closing of the partogram at the end of the delivery/ sending for EM/LSCS**



J. Date and Time of the Delivery

i) Date and Time of the Delivery:

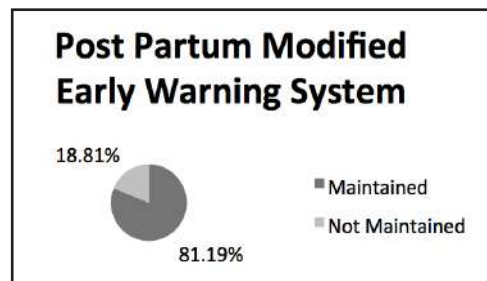
**Graph J1- Documenting of date and time of the Delivery in the partogram**



K. Post Partum Modified Early Warning System

i) Maintaining of Post Partum Modified Early Warning System:

**Graph K1- Maintaining of Post Partum Modified Early Warning System**



## VI. DISCUSSION

This audit provides an overview of effective usage of partogram obstetrics unit B, General Hospital, Kalutara. Partograms of relevant BHTs from 1st March 2016 to 31st May 2016 were assessed.

Total number of birth in study period was 571 and after applying exclusion criteria 423 deliveries were selected but, only 345 (82.04% of relevant BHTs) found due to logistic issues.

### A. Details of Partogram attached/Not attached in the BHTs

Majority of relevant BHTs were attached with a partogram(90.72%,N=313) and n=32,9.28% of relevant BHTs were found to have without a partogram.

N=313 is used for statistical purposes throughout the execution.

Relevant BHTs without a partogram(9.28%,n=32) were further described as 2nd stage admission to LR(n=4), IUDs(n=2), EM/LSCS(n=14) and other NVDs(n=12).

### B. Information of the Client in the Partogram

Information of the client were completed in majority of partograms as name of the client 97.49%,n=311,age 96.87%,n=309,gravida 95.92%,n=306, parity 94.36%, n=301, blood group 96.55%,n=308.

Date and time was mentioned in 89.34%, n=285 partograms.

In majority of the partograms special problems (25.08%,n=80) and special instructions (1.88%,n=6) were not given.

### C. Monitoring of Foetal Wellbeing During the Labour in the Partogram

Foetal heart rate in 1st stage of labour was recorded in the majority(80.88%) while 19.12% of partograms were not recorded.

Comment of CTG was included only in 4.08%, n=13 partograms.

Liquor colour mentioned in 34.17%, n=109 partograms while position (2.82%, n=9), caput (8.78%,n=28) and moulding(7.84%,n=25) mentioned in minimal number of partograms.

### D. Progress of the Labour in the Partogram

Contraction free interval (6.58%, n=21) and duration of contraction (6.27%,n=20) were recorded in very few partograms technical errors of recoding were noted in each and every partogram which were recorded.

Oxytocin drop rate mentioned only in 29.47%, n=94 partograms.

Abdominally descent was marked only in one partogram(0.31%,n=1) and it was technically incorrect. Cervical dilatation was marked only in 11.29%, n=36 partograms.

The majority of the partograms alert line (67.08%, n=214) and action line (65.83%, n=210) were drawn.

Descent vaginally was marked only in 23.2%, n=74 partograms but correct technique was not followed in marking.

### E. Monitoring of Maternal Wellbeing During the Labor in the Partogram

Maternal pulse was documented in only 50.16%, n=160 partograms and maternal blood pressure (43.26%, n=138), maternal body temperature (35.11%, n=112) were recorded only in minority.

### F. Monitoring of the 2nd stage of Labour

Fetal heart record in 2nd stage was noted only in two partograms (n=2,0.63%).

The time of fully dilated was noted only in three partograms(n=3,0.94%).

Commenced pushing was not documented in any of partogram(n=0,0%)

### G. Action Taken

Action taken was not documented in any partogram executed (0%, n=0).

### H. Closing of the Partogram

Partogram was closed only in 3.14%, n=11.

### I. Date and Time of the Delivery

In the majority (70.22%, n=224) date and time of delivery documented in the Post Partum Modified Early Warning System.

### J. Post Partum Modified Early Warning System

In the majority (81.19%, n=259) Post Partum Modified Early Warning System was maintained but technique was not assessed.

## VII. CONCLUSION

This study assessed the effective usage of partogram.

Client information is included in majority of partogram. Position, caput, moulding and CTG comments, were not included in majority.

Contraction free interval, duration of contraction and abdominally descent were not marked in the majority and the technical errors noted during marking.

Though alert line and action line were drawn frequently cervical dilatation was not marked in the majority.

Maternal monitoring during labour was not documented in the majority.

Action taken was not documented in the partogram. Fetal monitoring of the 2nd stage is not documented in almost all the time.

Closing of the partogram was done hardly.

Date and time of the delivery and Post Partum Modified Early Warning System was maintained in majority.

## VIII. RECOMMENDATIONS

Value of partogram in monitoring during the labour should be discussed.

Training programme on maintaining of National Partogram should be arranged and encouraged.

Practical issues in monitoring and documenting of contraction free interval, duration of contraction should be addressed.

Practical issues in monitoring and documenting in the 2nd stage of labour should be discussed. Importance of maternal monitoring during labour should be highlighted.

Reaudit should be done after a proper training programme in the days to come.

Further studies on maintaining partogram should be encouraged.

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## ACKNOWLEDGMENT

To Obstetric unit B, General Hospital-Kalutara and those who supported for the study.

# PROLONGED COMPUTER USE AND ITS EFFECTS ON VISION AMONG UNDERGRADUATES IN UNIVERSITY OF COLOMBO, SCHOOL OF COMPUTING

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**Abstract** - Computer Vision Syndrome (CVS) is a group of visual symptoms experienced in relation to the use of computers. Nearly 60 million people suffer from CVS globally, ranging from 64% to 90%, resulting in reduced productivity at work and reduced quality of life of the computer worker. The present study aims to describe the prevalence of CVS and its associated factors among undergraduates in University of Colombo, School of Computing. A cross sectional study was carried out in the University premises on 2nd, 3rd and 4th year students of University of Colombo School of Computing. Pattern of computer use, prevalence and extent of visual symptoms and some associated factors were analyzed. Statistical data is provided about the prevalence of visual symptoms and its co-relationship with the duration of exposure and associated other factors that have been identified. For the categorical variables chi square test was used and for continuous variables Students T Test was used.

Sample size was 112 (response rate – 74.6%). Mean age was 21.9±1.2 years (range 19-25 years) and 73 (65.2%) of the sample were males. Only 39 (34.8%) of the sample were females. Percentage of individuals with visual symptoms in the study population was 79 (70.5%). 33 (29.5%) students were asymptomatic. The most commonly reported complaint was headache (54.5%), followed by pain (33.9%), whereas the least common complaint was double vision (3.6%).

High prevalence of visual symptoms was observed (70.5%) among the study group. Technology professionals who

have nearly similar exposure to the computer screens have shown similar percentage of prevalence of visual symptoms but findings are much more less than the researches which were done on students. There is no association between prevalence of visual symptoms and duration of continued gaze upon the monitor and the duration of the course. But there is a significant association with the distance from the monitor and duration of daily computer usage.

**Keywords** - vision, computer, visual symptoms, computer vision syndrome

## I. INTRODUCTION

As we enter the 21st century, the growing use of computers in the home and office brings with it an increase in health risks, especially for the eyes. Effect of long term computer use on vision, called Computer Vision Syndrome (CVS), is affecting more and more people who find themselves constantly in front of computer screens. Reduced visual abilities, the pain and discomfort associated with the problem can affect quality of life, workplace performance & the enjoyment of day to day activities. According to Heyes et al., 2007, globally computer vision syndrome affects 64% - 90% among computer users & according to SenA et al., 2007, nearly 60 million people suffer from CVS globally & a million new cases of CVS occur each year. Worldwide there are several studies which have been done to determine the prevalence of computer vision syndrome, but there are only few studies done here in Sri Lanka.



Seshadhri et al, 2014, conducted a study to determine the prevalence of computer vision syndrome among Information Technology professionals working in software companies in Chennai. Study included a sample of 179 persons. Their inclusion criteria included persons working in current job for past 6 months & who use computer for more than 3hours per day or 15hours per week. The prevalence of computer vision syndrome found in this study was 69.3% which belongs to the category of moderate level overall incidence. They had also shown that there was no association between computer vision syndrome & total hours of working on computer per day (Seshadhri et al, 2014). In the above, study they have selected professionals working in software companies & also they haven't mentioned about the associated factors of computer vision syndrome. Our study is focused on university students where there is less exposure to computer screen comparing to above professionals & associated factors.

There was another study conducted by Logaraj et al., 2014 in same region as above study, Chennai. They had assessed the prevalence of CVS among medical & engineering college students of a University situated in the suburban area of Chennai. According to this study the prevalence of CVS among engineering students was 81.9% & among medical students was 78.6%. They also have shown that the students who used computers for 4-6 hours were at higher risk of developing the visual symptoms such as redness, burning sensation & dry eyes. This study had shown that there was a significant correlation between the increased hours of computer use & visual symptoms. This fact is against the conclusion made by the previous study (Logaraj et al., 2014).

A study which was conducted in Malaysia, had described the prevalence of some important visual symptoms among undergraduate students studying computing & medicine and some secretarial staff. They had found out 55% with burning sensation in the eyes, 61% with headache, 46% with redness of the eyes & majority, 87% with eye fatigue, among the symptoms of CVS. When the duration of the computer use was increased, the above scores also had increased supporting the fact that there was a significant correlation between the increased hours of computer use & visual symptoms (Sen and Stanley, 2007).

Recently, Reddy SC et al, 2013, had conducted a study on CVS to determine the prevalence visual symptoms, associated factors & knowledge and practices of computer use among university students in Malaysia. According to this study, there was 89.9% prevalence of one or more

visual symptoms of CVS & the most disturbing symptom that they had found was headache (19.6%) followed by eye fatigue (16.4%). The associated factors which increase the prevalence of visual symptoms were computer use of more than 2hours, wearing spectacles, computer screen at or above the level of eye and which decrease the prevalence of visual symptoms were looking at far objects in between work, use of eye drops, computer screen below the level of eye. Usage of radiation reducing filters & taking breaks in between computer use had not been shown to reduce visual symptoms (Reddy et al, 2007).

A study which was done among University students of Ajman, United Arab Emirates had shown the patterns of computer usage & related visual problems. The symptoms reported in this study were Headache with a prevalence of 53.3%, Burning sensation in the eyes with a prevalence of 54.8% & Fatigue eye with a prevalence of 48%. The females were at higher risk of developing visual symptoms. When the display screen was viewed at a distance more than 50cm, the prevalence of headache reduced by 38%. When screen radiation filters were not used, the prevalence of fatigue eyes was increased by 89% (Shantakumari N. et al., 2014). This study elaborates that the screen viewing distance & radiation filter usage are associated with the development of visual symptoms in long term computer use.

Brightness adjustment, Antiglare screens & Type of the monitor are some other associated factors which give rise to visual symptoms in computer vision syndrome. A study had shown that adjustment of the brightness of the screen, usage of antiglare screens & LCD monitors resulted in less prevalence of visual symptoms (Smita et al., 2012). When considering all these studies, it elaborates that there is a higher prevalence of computer vision syndrome worldwide, ranging from 64% to 90% which in turn reducing the quality of life, productivity, etc. & resulting in permanent eye damage. This highlights the importance of doing a research on Computer Vision Syndrome in Sri Lanka & also there are very few studies done here regarding this problem until present.

The common visual symptoms associated with the long-term computer use are the headache, eye strain, eye redness, periorbital pain & Dryness of the eyes. The common associated external factors are duration of exposure to computer screen, usage of spectacles, level of the eyes & computer screen, activities during computer use, usage of eye drops, radiation reducing screen filters, antiglare screens, brightness adjustment, type of monitor, screen viewing distance.

## II. METHODOLOGY

A cross sectional descriptive study was carried out on 2nd, 3rd and 4th year undergraduates of University of Colombo School of Computing, completing their degrees on information systems and computer science who have used computer more than 1 hour per day during past 2 months.

Modified version of an expert validated, self-administrated questionnaire, which has been used in a previous research on computer use and associated visual and musculo-skeletal symptoms in Sri Lanka (Ranasinghe P., et al., 2011) was used to gather information under headings of basic personal details, history of computer use, visual symptoms and factors related to computer use and vision. Visual symptoms sought for included dry eyes, sore eyes, red eyes, blurred vision (near and distal), retro orbital pain, excessive tearing, headache, disturbances of colour vision, double vision, twitching of the eyelids and the associated factors of interest were presence of diagnosed visual defect, use of lubricating eye drops, use of contact lenses, characteristics of the display monitor used and its placement. Data analysis was done using IBM SPSS Statistics 20th version.

Socio demographic characteristics, prevalence of long term computer use (using computer more than 3 hours per day for 6 months), prevalence of visual symptoms and prevalence of associated factors were described. Individual with even one visual symptom was considered as a symptomatic while presence of none of the symptoms was considered as asymptomatic. Presence of visual symptoms >3 was considered as severe while mild being presence of symptoms <3.

Any significant association between the associated factors of computer use and being symptomatic was sought using chi square test. Mean values of daily exposure to computer, distance to the monitor, duration of continued gaze upon the computer screen between asymptomatic and symptomatic groups were compared using student T test.

## III. RESULTS

### A. Socio-demographic characteristics.

The Sample size was 112 (response rate – 74.6%). Mean age was 21.9±1.2 years (range 19-25 years) and 73 (65.2%) of the sample were males. Only 39 (34.8%) of the sample were females. Total number of 48 (42.9%) students had

daily computer usage less than 6 hours while 64 students are using computer more than 6 hours per day. 61 students (54.5%) have been following the course for duration of less than a year. 91 (81.3%) of students were using computer for study purposes while 6 are (5.4%) using it for graphic designing and 14 (12.5%) are using it to access internet, mainly.

**Table 1. Presence of visual symptoms**

	<b>N (%)</b>
<b>Symptomatic</b>	79 (70.5)
<b>Severe</b>	41 (51.9)
<b>Mild</b>	38 (48.1)
<b>Asymptomatic</b>	33 (29.5)
<b>Long term users</b>	17 (15.2)
<b>Short term users</b>	95 (84.8)

### B. Presence of Visual Symptoms

Percentage of individuals with visual symptoms in the study population was 79 (70.5%). 33 (29.5%) students were asymptomatic. 17 (15.2%) students were found to be using computer more than 3 hours per day for 6 months. 95 (84.8%) were short term computer users. 41 (51.9%) were having severe visual symptoms while 38 (48.1%) were found to be having mild visual symptoms.

38 (33.9%) had pain around the eye and headache was present among 61 (54.5%). 25 (22.5%) had blurred near vision and 15 (13.5%) had blurred distant vision. 26 (23.2%) had dry eyes after computer use while 29 (25.9%) had sore eyes. 22 (19.6%) had red eyes, 27 (24.3%) had excessive tearing, 4 (3.6%) had double vision, 15 (13.5%) had twitching of the eyelids and (4.5%) disturbances in colour vision.

The most commonly reported complaint was headache (54.5%), followed by pain (33.9%), whereas the least common complaint was double vision (3.6%). The prevalence of each symptom in all participants, males and females are presented in Table 2. There was no significant association between visual symptoms and gender. There was no significant difference between the genders for any of the visual symptoms

### C. Factors associated with visual symptoms

1) Characteristics of the monitor: 68 users were using 15” monitors while 39 (30.4%) and 6 (5.4%) using 17” and

19” monitors. Majority were LED/LCD screen users 92 (82.1%) while only a very few 2 (1.8%) used only CRT monitors.

2) Other associated factors:Prevalence of diagnosed eye conditions among the population was 3 (2.7%). 86 (76.8%) individuals used to change brightness according to the state of the light of the environment. Total number of VDT filter users were 24 (21.4%) and 32 (28.6%) had noticed there’s a glare in the screen when they were working. Total number of spectacle users were 42 (37.5%) and 10 (8.9%) used to use lubricating eye drops to reduce prevalence of visual symptoms. Total number of contact lens users was 2 (1.8%).

**Table 2. Prevalence of visual symptoms and association with gender.**

Symptom	N	Total %	Female %	Male %	P value*
<b>Pain around the eye</b>	38	33.9	28.2	37	0.350
<b>Headache</b>	61	54.5	61.5	50.7	0.272
<b>Blurred near vision</b>	25	22.5	23.1	22.2	0.918
<b>Blurred distant vision</b>	15	13.5	7.9	16.4	0.212
<b>Dry eyes</b>	26	23.2	25.6	21.9	0.657
<b>Sore eyes</b>	29	25.9	20.5	28.8	0.342
<b>Red eyes</b>	22	19.6	25.6	16.4	0.243
<b>Excessive tearing</b>	27	24.3	28.2	22.2	0.483
<b>Double vision</b>	4	3.6	2.6	4.1	0.692
<b>Twitching of eyelids</b>	15	13.5	10.3	15.1	0.476
<b>Changes in colour visualization</b>	5	4.5	2.6	5.5	0.477

\*p value for association with gender

The association between presence of visual symptoms and gender, cleaning the monitor screen, using a filter,presence of screen glare, use of lubricating eye drops and use of contact lenses was assessed by using chi square test. Results are summarized in table 4. There was no statistically significant association between any of those factors and visual symptoms.

**Table 3. Characteristics of the monitors**

	N	%
<b>Monitor size</b>		
1. 15”	68	60.7
2. 17”	39	30.4
3. 19”	6	5.4
<b>Distance to Monitor from the eye</b>		
1. < 20 cm	69	61.6
2. 20 < cm	41	36.6
<b>Type of Monitor Used</b>		
1. CRT	2	1.8
2. LCD/LED	92	82.1
3. Both	18	16.1

**Table 4. Association of visual symptoms to vision related and computer related factors**

		Asymptomatic	Symptomatic	Total	X2	df	P value
<b>Gender</b>	<b>Male</b>	19	54	73	1.192	1	0.275
	<b>Female</b>	14	25	39			
	<b>Total</b>	33	79	112			
<b>Cleaning the Screen</b>	<b>Cleaning</b>	22	49	71	0.216	1	0.462
	<b>Not Cleaning</b>	11	30	41			
	<b>Total</b>	33	79	112			
<b>Filter use</b>	<b>Present</b>	8	16	24	0.220	1	0.619
	<b>Absent</b>	25	63	88			
	<b>Total</b>	33	79	112			
<b>Screen glare</b>	<b>Present</b>	9	23	32	0.039	1	0.844
	<b>Absent</b>	24	56	80			
	<b>Total</b>	33	79	112			
<b>Lubricating eye drops</b>	<b>Present</b>	1	9	10	2.002	1	0.157
	<b>Absent</b>	32	70	102			
	<b>Total</b>	33	79	112			
<b>Contact lens</b>	<b>Present</b>	0	2	2	0.851	1	0.356
	<b>Absent</b>	33	77	110			
	<b>Total</b>	33	79	112			

For students with visual symptoms mean values for course duration up to the date of data collection was 13.2 months and their mean daily computer usage was 7.37 hours. They kept monitor at a mean distance of 20.65 cm and mean duration of continuous staring at the monitor was 136 minutes. Students without visual symptoms had a mean course exposure of 14.58 months and 5.94 hours of mean daily computer usage. They also had a mean distance of 16.84 cm head to the monitor and mean duration of continuous staring of 102.88 minutes. Students T test was done to compare these results. There is a significant difference at 95% confidence level, between the mean values for daily computer usage for symptomatic students 13.2,  $p = 0.033$  ( $p < 0.05$ ) and with the distance to monitor,  $p = 0.008$  ( $p < 0.05$ ). There was no observed significant difference between mean values for course exposure and continuous gazing at the screen.

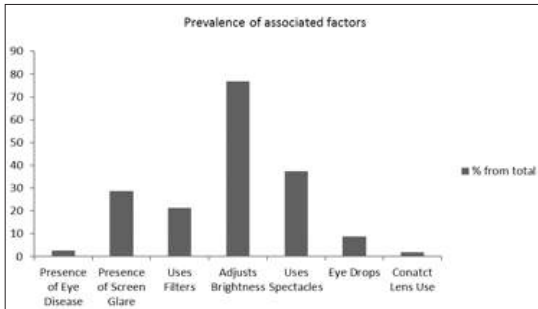


Figure 1. Prevalence of other associated factors

Table 5. Results of the student T tests

	N	Mean	SD	Significance value
<b>Duration of the course</b>				
Symptomatic	79	13.2	8.662	0.481
Asymptomatic	33	14.58	10.912	
<b>Daily Usage (hours)</b>				
Symptomatic	79	7.37	3.081	0.033
Asymptomatic	33	5.94	3.455	
<b>Distance to monitor (cm)</b>				
Symptomatic	79	20.65	7.174	0.008
Asymptomatic	31	16.84	5.014	
<b>Duration of gazing continuously (mins)</b>				
Symptomatic	75	135.59	186.821	0.378
Asymptomatic	33	102.88	151.874	

## IV. DISCUSSION

Majority of the study population were males 73 (65.2%) and used computer more than 6 hours a day 62 (57.2%). Majority, 61, was following the course for a period of time less than a year (54.5%).

High prevalence of visual symptoms was observed (70.5%) among the study group, which is nearly similar to the findings (69.3%) in some of the previous researches on long term computer users. (Sheshadhri et. Al, 2014). But it appears near to the lower limit of the range of the global prevalence of visual symptoms (64% - 90%) that the other researches have revealed (SenA et al., 2007).

Compatible with the Reddy SC et al., 2007 and Shantakumari N. et al., 2014 headache was the most prevalent symptom. Technology professionals who have nearly similar exposure to the computer screens have shown similar percentage of prevalence of visual symptoms but findings are much more less than the researches which were done on students. (89.9% Reddy SC et al., 2007) (Logaraj et al., 2014). Since there was no significant difference was observed in the T test there is no association between prevalence of visual symptoms and duration of continued gaze upon the monitor. But there is a significant association between daily computer usage and visual symptoms. Mean value for students with visual symptoms for daily computer use was 7.37 hours while asymptomatic students had a value of 5.94 hours. Risk for developing visual symptoms, therefore, increases as the daily computer usage increases, as suggested by the student t test. There was observed significant association between visual symptoms and increased distance to the computer monitor. There were no previous researches supporting this evidence.

Contradictorily to the findings of Smita et al., 2012, there was no significant association between brightness adjustment, using ntlglare screens. There was no association between prevalence of visual symptoms and VDT filter usage. This is supported by the results of Reddy SC. Et al., 2007 while findings of Shantakumari N. et al., strongly suggest vice versa. This again could be due to less number of VDT filter users in the sample.

In contrast to the results of Reddy SC. Et al., 2007 there was no significant reduction of visual symptoms caused by using eye drops.

Main conclusion to be drawn was there is a high prevalence of visual symptoms among long term computer users. This is compatible with the researches done on the area by other Asian countries. But it appears to be lying in the lower margin of the range suggested by those researches. Hence, though long term computer users have high prevalence of visual symptoms, it appears to be lower in comparison with the globally accepted range. Most common visual symptom caused by computer use is headache.

According to the results there is no influence of gender upon prevalence of any of the visual symptoms observed. Increased daily duration of computer use is associated with high prevalence of visual symptoms while duration of the course or duration of continuous gaze upon the screen without taking a rest had no effect on the visual symptoms. Results regarding contact lens use and visual symptoms prevalence could be a result of the smaller population size and smaller number of contact lens users taking part in the research. Further research focused on the subject is needed for a better conclusion in that matter.

According to the conclusions we recommend the computer users to keep their daily exposure to computer screen less than 6 hours. We also strongly suggest doing prospective studies on association between duration of daily computer use and prevalence of visual symptoms. Using an objective method to identify prevalence of symptoms would help in acquiring a higher accuracy.

It would be better to select a larger population size in future researches focused on individual factors associated with visual symptoms. Researches more focused on association between contact lens use, distance to the monitor screen and visual symptoms might suggest difference results compared to our study. We suggest doing studies more focused on these areas with use of proper inclusion and exclusion criteria to include a reasonable number of participants.

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# *Basic And Applied Sciences*

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“Changing dynamics in the global environment;  
Challenges and opportunities for  
Basic and Applied Science Research”



## SESSION SUMMARY

### Plenary session

The session theme was “Changing dynamics in the global environment; Challenges and opportunities for Basic and Applied Science Research”. Plenary session was chaired by the Emeritus Prof. Ajit M Abeyssekara is an emeritus Professor of Chemistry at Department of Chemistry, University of Sri Jayewardenepura, Sri Lanka. He is also a fellow of the National Academy of Sciences of Sri Lanka and a fellow of the Institute of Chemistry, Ceylon. He works closely with the National Institute of Education and the Department of Examinations of the Ministry of Education, and the National Science Foundation of the Ministry of Science and Technology. He has served as the president of section E-2 of the SLAAS, and also as Director of the Bandaranaike Memorial Ayurveda Research Institute.

The plenary session speakers were Prof. Ramesh Rajan, Prof. Mirani Weerasooriya, Prof. Chandrani Wijeyaratne and Prof. Mahinda Wickramarathne. Prof. Ramesh Rajan is currently working as a professor in the Department of Physiology, Monash University, Australia. The title of his speech was “Processing speech in noise – a powerful window into the human brain”. He described his studies on the contribution of bottom-up auditory processes and top-down cognitive to speech comprehension in noise and then described how these are altered by brain disorders like autism spectrum disorders, Parkinson’s disease and Friedrich’s ataxia, but spared (at least in early stage) multiple sclerosis. Prof. Mirani Weerasooriya is a Senior Professor of Parasitology at Department of Parasitology, Faculty of Medicine - University of Ruhuna. The title of her speech was “Elimination of Lymphatic Filariasis in Sri Lanka: Advances in diagnosis and management of surveillance”. She talked about the role of the scientists at the present will be the continuation of surveillance and evaluation utilizing the recommended tools like night blood for microfilariae, tests to detect circulating antigen to *Wuchereria bancrofti* and other techniques to detect parasite DNA in humans and mosquitoes. Further she talked about the application of Immunochromatographic card test (ICT) and other

tests used by Program to Eliminate Lymphatic Filariasis (PELF); new Alere Filariasis Test Strip (FTS) against Card test. Prof. Chandrani Wijeyaratne is an emeritus Professor of Botany at department of Botany, University of Sri Jayewardenepura, Sri Lanka since her retirement in 2014 and the title of her speech was “Air Quality Monitoring Potential of Lichens”. Her talk was primarily based on Lichens, are extremely sensitive to the impacts of habitat modification and air pollution, which is a major environmental issue both in developed and developing countries. She also mentioned how to correlate ambient Sulphur dioxide (SO<sub>2</sub>) and Nitrogen dioxide (NO<sub>2</sub>) levels with corticolus lichens. She pointed out that SO<sub>2</sub> is considered to be the primary factor causing the death of lichens in most urban and industrial areas, with fruticose lichens being more susceptible to SO<sub>2</sub> than many foliose and crustose species. Ozone, PAN and nitrogen oxides are also toxic to lichens in sufficient concentrations. Prof. Mahinda Wickramarathne is the dean of Faculty of Allied Health Sciences at University of Peradeniya, Sri Lanka and his talk was on “Drug Discovery from Natural Products in Sri Lanka ...Are we in the right path”. He pointed out numerous work has been done towards the development of new drug entities from our medicinal plants during the last half century without much direct successes. He further mentioned rather than isolating single bioactive compounds, scientists and pharmacists can get together and formulate crude drugs with known pharmacological activity with proper quality parameters.

### Technical sessions

There were four technical sessions with subthemes of Health and Nutrition, Environmental Sciences and Drug Discovery and Development. There was a total of 18 oral presentations and 23 poster presentations. The price for the best oral presentation went to JWN Yasara and P Soysa on “Anti-oxidant and anti-proliferative activity of Triphala” and the best poster presentation went to JMSA Bandara and WJ Wickramarachchi on “Evaluation of the efficacy of dandruff care herbal oil in the management of dārunaka (dandruff)”. The chair of the first session was Prof. J

Welihinda. The first presenter was DMWD Divisekera and her talk was “Reporting the in vitro antimicrobial activity of *Lactobacillus plantarum* B\_16LAB isolated from Sri Lankan green banana (*Musa* spp)”. The second presenter was DMCHB Dissanayaka and the title of speech was on “Macronutrient intake and nutrition knowledge of endurance swimmers of the civil security department of Sri Lanka”. The third presenter was KP Manawadu and his talk was on “Effect of relative strength and skeletal muscle mass percentage on performance of junior swimmers in Colombo district”. The fourth presenter was WMNS Wijethunga and the title of her speech was “- Dietary supplement usage and nutrition knowledge of team sport athletes in selected universities”.

The chair of the second session was Dr. Sirimal Premakumara. The first presenter was V Gunarathne and the title of speech was “Influence of water content, ligands and protons on metal release in heavy metal rich soils”. The second presenter was RWK Amarasekara and her talk was on “Quantification of microorganisms associated with particulate matter within Kandy city”. The third presenter was WMNH Kumari and she presented on “Molecular characterization and phylogenetic analysis of *Staphylococcus* Sp. Found from industrial waste water”. The fourth presenter was DIVW Thilakarathna and the title of speech was “Molecular and morphological diversity assessment in flowering related traits of mungbean (*Vigna radiata*)”.

The chair of the third session was Prof. CL Gunasekara. The first presenter was HMAJ Herath and the title of her speech was “Antioxidant activities of soluble phenolic compounds of Sri Lankan rice varieties”. The second presenter was MKGB Dilrukshi and her talk was on “Determination of in vitro antimicrobial activity of

selected marine sponges found in Sri Lanka”. The third presenter was D Perera and his talk was on “Optimization of parameters and development of cost effective method for isolation and propagation of umbilical cord blood derived mesenchymal stem cells”. The fourth presenter was again HMAJ Herath and the title of her speech was “High antioxidant efficacy of legume phenolics extracted at low temperature”. The fifth presenter L Thanabalasundaram talked about “Comparing the metabolic activity of stem cells in collagen gels as a potential therapeutic in nerve tissue engineering”.

The chair of the fourth session was Dr. KMN Kumarasinghe. The first presenter was DR Gimhani and the title of her speech was “Progress of mapping QTLs for root traits on chromosome 10 in rice (*Oryza sativa*) using elite rice background”. The second presenter was SAS Jayawardana and her talk was on “Antimicrobial properties of finger millet (*Eleusine coracana*) varieties of Sri Lanka”. The third presenter was JWN Yasara and the talk was on “Anti-oxidant and anti-proliferative activity of Triphala”. The fourth presenter was CM Rajapaksha and the title of her speech was “Phytochemical screening and antioxidant activity of water and ethanolic extracts of *Annona muricata* (soursop) fruit”. The fifth presenter DU Rajawardana talked about “Probiotic potential of exopolysaccharide producing *Lactobacillus plantarum* sp. Isolated from Sri Lankan dairies”. The judges of the technical session were Snr. Prof. W.D. Ratnasooriya, Snr. Prof. RN Pathirana, Dr. KMN Kumarasinghe and Dr. JMKB Jayasekera and Dr. C. Hettiarachchi. Apart from the oral presentations there were papers presented as posters. The details of those are shown below.

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*Plenary  
Speeches*

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# PROCESSING SPEECH IN NOISE - A POWERFUL WINDOW INTO THE HUMAN BRAIN

**Prof R Rajan**

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Verbal communication remains the most powerful way in which humans' exchange and disseminate information, thoughts and emotions. Most normal everyday conditions involve speech communication in noisy backgrounds like lecture rooms, restaurants, markets, etc and hence comprehension of speech requires the use of skills sets beyond the bottom-up processes of hearing but also higher order cognitive processes such as lexical memory, working

memory, executive control and attention, among others. In this talk I will describe the studies in my laboratory on the contribution of bottom up auditory processes and top-down cognitive to speech comprehension in noise and then describe how these are altered by brain disorders like autism spectrum disorders, Parkinson's disease and Friedrich's ataxia, but spared (at least in early stage) multiple sclerosis.

# ELIMINATION OF LYMPHATIC FILARIASIS IN SRI LANKA: ADVANCES IN DIAGNOSIS AND MANAGEMENT OF SURVEILLANCE

**Prof MV Weerasooriya**

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The World Health Association in July 2016 validated Sri Lanka as having eliminated Lymphatic Filariasis (LF) as a public health problem. LF is a disabling mosquito borne disease caused by nematode parasitic worms *Wuchereria bancrofti* and *Brugia malayi* in Sri Lanka. However, latter was eradicated in nineteen sixties. In 1997 the World Health Assembly passed a resolution calling for the elimination of the disease. The World Health Organization established the Global Programme for the Elimination of Lymphatic Filariasis (GPELF) in 2000 aiming to achieve total elimination by 2020. The programme had two principal goals to interrupt the transmission of infection in the entire 'at risk' population by treating every individual annually with a single dose of two drug regimen to alleviate the suffering and decrease the disability of those already with the clinical disease by reducing the secondary bacterial and fungal infections of the limbs and genitals and conduct of hydrocelectomies for hydrocoeles. In Sri Lanka the disease was considered to be endemic in three provinces, southern, western and north western and covering eight districts.

The Ministry of Health, initiated the national programme for the elimination of lymphatic filariasis (PELF) in 2002 covering the three endemic provinces. Five rounds of mass drug administration were completed by 2006. The morbidity control programme too was continued through the years. Having completed ten years of surveillance after

the last MDA, Sri Lanka has now reached the elimination goal.

The country needs to maintain the success and to prevent resurgence of the disease. The role of the scientists at the present will be the continuation of surveillance and evaluation utilizing the recommended tools like night blood for microfilariae, tests to detect circulating antigen to *Wuchereria bancrofti* and other techniques to detect parasite DNA in humans and mosquitoes. The application of ICT card and other tests used by PELF; new Alere Filariasis Strip Test (FTS) against Card test; application of urine ELISA; application of independent questionnaire on community leaders and validating data obtained by clinicians and with urine ELISA; LAMP test and PCR used by PELF will be discussed. In addition, screening, testing of sentinel sites, hot spots, borderline districts, migrants and value of independent surveys too will be discussed.

The remaining hot spots of high endemicity like in Galle, finding of *Brugia malayi* resurgence in the country and less attention paid for a disease after elimination are the challenges at present. Another important aspect of surveillance is to monitor Community Home Based Care approach to alleviate the suffering caused by LF. The newer techniques used for this and continuation of disability alleviation services on a larger scale will be discussed.

# AIR QUALITY MONITORING POTENTIAL OF LICHENS

**Prof C Wijeyaratne**

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Although appearing to be a single organism, lichen is actually a symbiotic partnership between a fungus and one or more photosynthetic organisms, an alga or cyanobacterium. Typically, the fungal partner provides most of the composite organism's structure and mass, thus exchanging physical protection for carbohydrates manufactured by the photosynthetic partner.

Together, the fungus and its partner(s) can inhabit a much wider variety of habitats and conditions than any could on their own. Lichens are extremely sensitive to the impacts of habitat modification and air pollution, which is a major environmental issue both in developed and developing countries.

This sensitivity is the foundation of their use as biological monitors or indicators of air pollution. In this respect, they serve as early warning detectors of environmental damage in much the same way that Pap tests are used to detect cancer in early treatable stages. Lichens exhibit changes in health, biodiversity and elemental composition long before any other plant or animal species exhibit any visible symptoms. SO<sub>2</sub> is considered to be the primary factor causing the death of lichens in most urban and industrial

areas, with fruticose lichens being more susceptible to SO<sub>2</sub> than many foliose and crustose species. Ozone, PAN and nitrogen oxides are also toxic to lichens in sufficient concentrations. Distribution mapping is the first classic field method used to indicate air quality using lichens. The total number of species per site (richness), the percentage of the quadrants in which particular species can be found (frequency), presence or absence of indicator species, and the estimated or measured cover are different parameters used in monitoring of lichens. In Sri Lanka, there were no previous data on the relationship of lichens with air pollutants.

Thus, studies were conducted to correlate ambient Sulphur dioxide (SO<sub>2</sub>) and Nitrogen dioxide (NO<sub>2</sub>) levels with corticolous lichens. Thirty-one sites falling on six transects extending upto 40 Km from Colombo city to suburbs were selected and area of each site was 1Km<sup>2</sup>. Computed lichen diversity (Shannon's diversity) on each site. It was evident that lichen diversity values increased when moving away from the city while SO<sub>2</sub> and NO<sub>2</sub> decreased concurrently, indicating that lichen diversity assessments can be successfully exploited in pollution monitoring in tropical countries as well.

# DRUG DISCOVERY FROM NATURAL PRODUCTS IN SRI LANKA A WAY FORWARD

**Prof DBM Wickramaratne**

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Potential resources for development / discovery of novel drugs would be Combinatorial chemistry, Structure-based drug design, In Silico drug development (SAR) and from Natural organisms. Since Sri Lanka processes well documented literature on curative potentials of plants and other natural sources in Deshiya Chikitsa and Ayurveda medical system, the exploring of medicinal plants for new drug entity would be the prime choice. This is again confirming by Sri Lanka being a hot spot in biodiversity in the Indian ocean. During the last half century, numerous work has been done towards the development of new drug entities from our medicinal plants without much direct successes.

The isolation of natural products from endemic species in 1960s has been evolved during the period to testing compounds for various in vitro and in vivo assays, elucidation of many novel structures, even getting national and international patents. Many compounds with high and specific biological activity have been isolated by different groups but none of them could reach the clinical trials mainly due to the lack of collaboration and funding. Development of a new drug will cost nearly one billion US dollars. According to the WHO and UN Reports more than 80% of world population is still depending on Native Medicine (mainly Plant based) for their primary health care. During the last two decades, the importance of traditional and complementary medicine [T and CM] has

been well recognised, and now T and CM is widely used around the world and valued for a number of reasons. At the International Conference on Traditional Medicine for South- East Asian Countries in February 2013, the WHO Director-General, Dr Margaret Chan, stated that “traditional medicines, of proven quality, safety, and efficacy, contribute to the goal of ensuring that all people have access to care.

For many millions of people, herbal medicines, traditional treatments, and traditional practitioners are the main source of health care, and sometimes the only source of care. In Sri Lanka, there are handful of pharmaceutical companies formulating herbal remedies into tablets, capsules or syrups. These productions should be expanded into other remedies so that the native practitioners can have ready access to standardised drugs at ease. So, the researches working on natural products drug discovery can go through this detour and formulate crude drugs with better therapeutic index. Most of the cases when the activity guided fractionation continues either you lose the activity or the therapeutic index decreases (increase the toxicity) or you stuck with the purification. So rather than isolating single bioactive compounds scientists and pharmacists can get together and formulate crude drugs with known pharmacological activity with proper quality parameters. That will capture ever growing local and foreign market.

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*Technical  
Session*

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(ORAL & POSTER PRESENTATIONS)



# BOX-JENKINS APPROACH TO FORECAST MONTHLY GOLD PRICE IN SRI LANKA

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**Abstract** - Depending on recent records, the price of gold has been rising day by day more than the past; similar characteristics has been shown in Sri Lankan gold price as well. What would be the causes behind this? Basically, this study has been carried out on two levels. For first level, we constructed models to forecast monthly gold price. The data was mined from World Gold Council and Central Bank of Sri Lanka. The sample data of gold price were gathered from 2007 January to 2016 March in the currency of US dollars per troy ounce. It was converted into Sri Lankan rupees per 22 carats. 75% of data were used to build the model and remaining data were used to forecast the gold price and to check the accuracy of the model. Box-Jenkins, Auto Regressive Integrated Moving Average (ARIMA) methodology has been used to build forecasting models.

**Keywords** - ARIMA, Gold price, ADF test

## 1. INTRODUCTION

Identifying the movements of the world economy remains uncertainty in many trades financial policy making process is very essential. Further foreign investors are not interested in investing on local stocks when countries currency is depreciating, as it would be a reason to diminish their return on invested assets. In such situations investors try to diversify their investments across multiple portfolios such as precious metal, bonds etc. As a result, they tend to shift from high risk instruments to less risk instruments with the intention of minimizing the loss. Commodities are among these instruments that may protect themselves from particular risks. Therefore, precious metals such as gold and silver and gems are popular among investors in past decades. Generally, there are many factors such as company performance, dividends, Inflation rate, interest rate, exchange rate, gold rate etc.. The last several years have seen a rapid rise in the demand of gold. Sectors where

the gold has been used is expanded in different areas such as medicine, engineering and environmental management. According to the World Gold Council (WGC) records the annual volume of gold bought by investors has increased by "at least 235% over the last three decades. Not only that gold price has increase in several levels [4]. In order to that Sri Lankan gold price has shown remarkable growth in present (see [www.ideabeam.com](http://www.ideabeam.com)).

Therefore, it is highly demand and standard metal among others. Sri Lanka has a long traditional association with the international Gem and jewelry trade and identified as a significant resource place for gold. Over past few decades Sri Lanka gold shows a remarkable position in the international gold market in parallel to local market; as a result of that Colombo Gold Centre is housed with 83 jewellery stalls in Pettah, Colombo. However, the global gold prices were dropping in time to time [1] which impacted to local gold market also. Due to this rapid inflation of gold price in global gold market many countries have done the statistical analysis [2,3,4] from different aspects. Therefore, the necessity of statistical analysis for gold prices inflation in Sri Lanka is very important to identify the drop downs to take recovery steps as much as earlier. In [6] has done the statistical modelling for the Sri Lankan gold price volatility and introduced models.

## 2. MATERIALS AND METHODS

The study is based absolutely on secondary data obtained from various data sources. This secondary data is available in the site [www.kitco.com](http://www.kitco.com) and world gold council website [www.worldgold.com](http://www.worldgold.com). The data of gold price (in US per troy ounce) were collected from 2007 January to 2016 March. US dollar exchange rates for Sri Lankan rupees were taken from Sri Lanka Central Bank website and inflation rates were captured from the site [www.goldpinflation.com](http://www.goldpinflation.com).

**2.1 Preliminary Analysis**

At the preliminary stage prior to fit the Auto regressive model, the following techniques were carried out to get an idea about the data and its behaviour.

**2.1.1 Plot of Time Series**

It is to inspect for extreme observations, missing data, or elements of non-stationary such as trend or seasonality or cyclic pattern or irregular variations.

**2.1.2 Augmented Dickey- Fuller test**

Augmented Dickey- Fuller (ADF) test is used to test whether the series has a unit root. It is to confirm, statistically, that the stationary of series in terms of trend availability.

The test statistic for the model  $y_t = \rho y_{t-1} + u_t$  with

$$-1 < \rho < 1, \text{ is } DF = \frac{\hat{\rho}}{Se(\hat{\rho})} \sim t_{n-1}$$

is where  $y_t$  is the response variable at time  $t$ ,  $u_t$  is the white noise and  $n$  is the number of observations. The hypothesis to be tested in this test is  $H_0$ : series is non-stationary ( $|\rho|=1$ ) versus  $H_1$ : series is stationary ( $|\rho|<1$ ).

**2.1.3 Kruskal- Wallis test**

Kruskal- Wallis test is used to confirm the seasonality in the series. The hypothesis to be tested in this test is,  $H_0$ : series has no seasonality versus  $H_1$ : series has seasonality. The test statistic of Kruskal- Wallis test is defined as:

$$H = \frac{12}{N(N+1)} \sum_{i=1}^L \frac{R_i^2}{n_i} - 3(N+1) \sim \chi^2_{L-1}$$

where  $N$  is the total number of rankings,  $R_i$  is the sum of the rankings in a specific season,  $n_i$  is the number of the rankings in a specific season and  $L$  is the length of the season.

**2.1.4 Autocorrelation function and partial autocorrelation function**

In time series analysis, a process of examining the autocorrelation function (ACF) and partial autocorrelation function (PACF) is to determine the nature of the process under consideration.

**2.1.5 Autocorrelation function**

Autocorrelation function (ACF) at lag  $k$  is defined by

$$\rho_K = \frac{Cov(Y_t, Y_{t+K})}{\sqrt{Var(Y_t)Var(Y_{t+K})}}$$

The first several autocorrelations are persistently large in the graph of ACF and trailed off to zero rather slowly, it can be assumed that a trend exists and the time series is non-stationary. If the series is stationary, then ACF graph must decay exponentially.

**2.1.6 Partial autocorrelation function**

Partial autocorrelation function (PACF) between is the conditional correlation between  $Y_t$  and  $Y_{t+k}$  and defined as follows:

$$\phi_K = cor(Y_t, Y_{t+K} | Y_{t+1}, Y_{t+2}, Y_{t+3} \dots Y_{t+K-1})$$

In other words, the PAC between  $Y_t$  and  $Y_{t+k}$  is the autocorrelation between  $Y_t$  and  $Y_{t+k}$  after adjusting for .

$$Y_{t+1}, Y_{t+2}, Y_{t+3} \dots Y_{t+K-1}$$

**2.2 Auto Regressive Moving Averages (ARMA) Model**

Auto Regressive Moving Averages (ARMA) Model is a statistical model describing the relationship between an output variable  $Y_t$  and one or more input variables  $Y_{t-1}$ 's and white nose terms.

$$Y_t = \alpha_1 Y_t + \alpha_2 Y_{t-1} + \alpha_3 Y_{t-3} \dots + \alpha_p Y_{t-p} + \beta_1 e_{t-1} + \beta_2 e_{t2} + \dots + \beta_q e_{t-q} + e_t$$

where  $e_t \sim N(0, \sigma^2)$

It may be rewritten as  $\phi(B)X_t = \theta(B)e_t$  where

$$\phi(B) = 1 - \phi_1 B - \phi_2 B^2 - \phi_3 B^3 - \dots - \phi_p B^p \text{ and}$$

$$\theta(B) = 1 + \theta_1 B + \theta_2 B^2 + \dots + \theta_q B^q$$

are polynomials in B of degree p and q respectively, and  $\{e_t\}$  is a sequence of independent and identically distributed random variables with mean zero and variance  $\sigma_e^2$

### 2.3 Residual Analysis

Before using the model for forecasting, it must be checked for adequacy. Diagnostic checks are performed to determine the adequacy of the model. Accordingly, the residuals should be random and normally distributed with constant variance. The following tests are carried out for the residual analysis:

#### 2.3.1 Anderson- Darling

The Anderson- Darling (AD) test is used to test if a sample of data comes from a population with a specific distribution. It is a modification of Kolmogorov- Smirnov (K-S) test and gives more weight to the tails than does the K-S test. Here the hypotheses are  $H_0$ : The data follow normal distribution versus  $H_1$ : The data do not follow normal distribution. The test statistic of AD test is:

$$A^2 = -N - \sum_{i=1}^N \frac{(2i-1)}{N} [\ln F(Y_i) + \ln(1 - F(Y_{N+1-i}))]$$

where  $F$  is the cumulative distribution function of the specified distribution,  $Y_i$  are the ordered data and  $N$  is the total number of observations.

#### 2.3.2 Lagrange’s Multiplier test

Lagrange’s Multiplier (LM) test is used to test the independency of residuals. It is an alternative test of Durbin Watson test for auto correlation among residuals. The null hypothesis to be tested is that,  $H_0$ : there is no serial correlation of any order. The individual residual autocorrelations should be small. Significant residual autocorrelations at low lags or seasonal lags suggest that the model is inadequate. The test statistic of LM test is:

$W = nR^2 \sim \chi_K^2$  where, K is the number of regressors in the auxiliary regression (only linear terms of the dependent variable are in the auxiliary regression),  $R^2$  is the determination of coefficients and  $n$  is the number of observations.

#### 2.3.3 White’s General test

White’s general test is used in order to check constant variance of residuals. Accordingly the null hypothesis is  $H_0$ : Homoscedasticity against the alternative Hypothesis  $H_1$ : Heteroscedasticity.

Test statistic of White’s General test is: where,  $W = nR^2 \sim \chi_K^2$   
K is the number of regressors in the auxiliary regression (squared terms of the dependent variable are also included in addition to terms in the LM test in auxiliary regression),  $R^2$  is the determination of coefficients and  $n$  is the number of observations.

#### Model Validation

It is important to evaluate performance of fitted model on the basis of the fit of the forecasting. Measure of forecast accuracy should always be evaluated as part of a model validation effort.

#### 2.4 Mean absolute percentage error

Mean absolute percentage error (MAPE) is the average of the sum of the absolute values of the percentage errors. It is generally used for evaluation of the forecast against the validation sample. To compare the average forecast accuracy of different models, MAPE statistics is used. It is

defined as, 
$$MAPE = \frac{1}{n} \sum_{t=1}^n \left| \frac{Y_t - \hat{Y}_t}{Y_t} \right| \times 100$$

where  $Y_t$  is the response variable at time  $t$  and  $n$  is the number of observations. Practically if MAPE is less than 10% then the fitted model is highly recommended for forecasting.

## 3. RESULTS AND DISCUSSIONS

**TIME SERIES MODELS TO FORECAST GOLD PRICE**  
This chapter includes the fitted Time Series models to forecast gold price. Preliminary analysis has been carried out to check the validity of the data series for the time series analysis and to understand the behavior of the data series. Under Auto Regressive Integrated Moving Average model building techniques three models were discussed.

#### 3.1 Preliminary Analysis

After collecting data it is necessary to test for its suitability to carry on stationary time series analysis. The Figure 3.1 shows the time series plot for monthly gold price in Sri Lanka which consists of 108 observations.

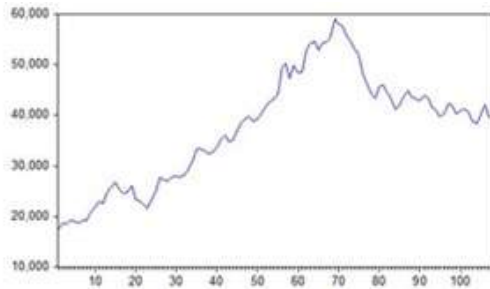


Fig. 3.1: Time series plot of monthly gold price in Sri Lanka from Jan. 2007 to Dec. 2015. The X axis denote the number of months and Y axis denote the gold price(LKR).

Reference to the Fig 3.1, we can see several interesting features. First, data is positively autocorrelated. Second, it exhibits rapid increase which maximized around 2012(62). From 2012(62) onwards there was a significant decline until 2015(108). Further it exhibits small fluctuations but not large swings up and down. However overall trend goes upward which implies that the data is not stationary. Further non stationarity of data series can be justified by autocorrelation(ACF) and partial autocorrelation(PACF) graphs as well.

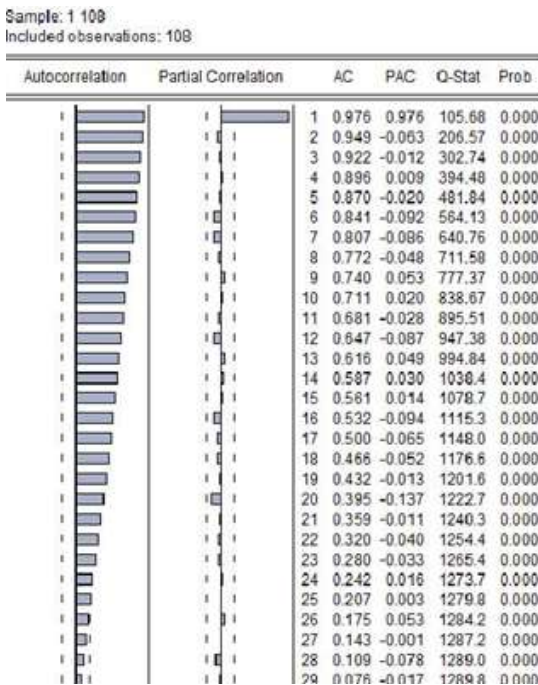


Fig. 3.2: Shows the Correlogram of gold price

Together with its sample ACF and PACF are given in Figure 4.2 we can see that the sample ACF dies out very slowly, while the sample PACF is only significant at the first lag. Also note that the PACF value at the first lag is very close to one. All this evidence suggests that the process is not stationary. Consolidated Unit Root Test, Augmented Dickey-Fuller and Phillips-Perron(PP) tests test with intercept to prove data are not been stationary in statistically.

Table 3.1: Shows that the p values for the ADF and PP test statistics

Original Series	ADF t- statistic	PP Adj. t-statistic
Probability Value	-1.866564	-1.866564
	0.3469	0.3469

Table 3.1, p values are given for test critical value of 5% significant level. Depending on hypothesis for ADF and PP tests we can reject the null hypothesis  $H_0$  and accept the alternative hypothesis  $H_1$  said that the data series has no unit root means that the time series data is non stationary.

Further there is no special pattern exists in the sample ACF graph means that we can conclude the absences of seasonality in the gold price.

To confirm the stationarity of the first difference series we carried on the ; Unit Root test, Augmented Dickey Fuller and Phillips-Perron tests have been carried out and the results of 5% of significant level are shown the in the Table 3.2.

Table 3.2: ADF test and PP test values for the first difference series.

First difference Series	ADF t- statistic	PP Adj. t-statistic
Probability Value	-8.36265	-8.288831
	0.0000	0.0000

Depending on the two tests results ADF and PP test we can conclude the data series is stationary at the 1<sup>st</sup> difference as the p-value of 1<sup>st</sup> is difference series is 0:0000 less than the significant level 0.05; the null hypothesis  $H_0$  is rejected and accept the alternative  $H_1$  hypothesis.

3.2.2 Model Identification and Coefficient Estimations.

To find the significant AR and MA terms for the suggested model E-views 7 software has been used. The Table 3.3 showed the significance of coefficients ar(3) and ma(3) of ARIMA model . Probability values of two coefficients less than the 5% indicates both values are significant.

**Table 3.3 Parameter Estimates of ARIMA model 1 (Eviews output)**

**DEPENDANT VARIABLE D(GOLD PRICE)**

Variable	coefficient	Std error	P value
AR(3)	0.9271	0.01610	0.0000
MA(3)	-0.9370	0.0651	0.0000

R-squared 0.0210                      Mean dependant var 195.186  
 S.E of regression 1507.66    S.D dependant var 1516.34  
 Akaike criterion 17.49            Schwarz cretrion 17.54  
 Durbin Wason stat 1.635

Due to the large value of standard error of the fitted model it is 1507.66, we will not recommended as adequate model because most of the estimates will be mislead. Therefore log transformation is used to stabilize the variance. The box cox transformation has been carried out to identify which transformation should be taken into account. Figure 3.3 shows estimated value is 0 indicates log transformation is appropriate for god price to stabilize the variance.

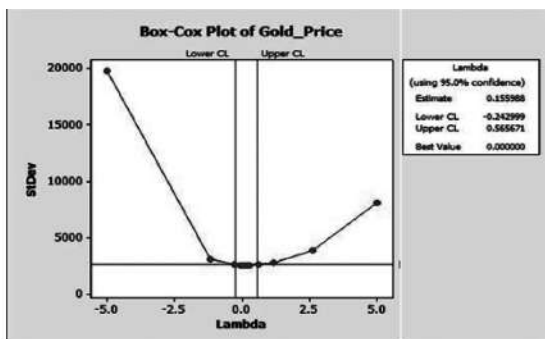


Fig: 3.3: Box Cox transformation plot

Table 3.4 shows ARIMA model 2 for log transformed data series.

**Table 3.4 Parameter Estimates of ARIMA model 2 (Eviews output)**  
**Dependant variable d(log(gold price))**

Variable	coefficient	Std error	P value
AR(3)	0.9086	0.04634	19.6058
MA(3)	-0.94437	0.04475	-21.1033

R-squared 0.0435                      Mean dependant var 0.00695  
 S.E of regression 0.034188    S.D dependant var 0.040180  
 Akaike criterion -3.6066        Schwarz cretrion -3.5557  
 Durbin Wason stat 1.67

**Residual Analysis of model 2**

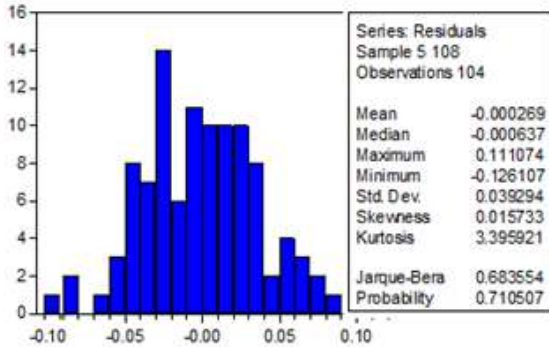
After finding the significant coefficients residual analysis has been carried out to check the adequacy of the model. The residual sample autocorrelation and partial auto correlation function in Figure 3.4 do not presence any structure and all the values lie between 95% of confidence interval. And their probability values are greater than 5% of significance level means that residuals have nonstationary structure. Thus we can accept the H0 means that there is no correlation among residuals.

Autocorrelation	Partial Correlation	AC	PAC	Q-Stat	Prob
1	0.160	0.160	2.7292		
2	-0.053	-0.081	3.0334		
3	-0.068	-0.047	3.5373	0.060	
4	-0.032	-0.017	3.6471	0.161	
5	0.060	0.062	4.0427	0.257	
6	0.165	0.144	7.1138	0.130	
7	-0.024	-0.074	7.1793	0.208	
8	-0.127	-0.094	9.0220	0.172	
9	-0.061	-0.013	9.4599	0.221	
10	0.059	0.066	9.8647	0.275	
11	0.170	0.131	13.302	0.149	
12	0.043	-0.032	13.520	0.196	
13	-0.119	-0.096	15.245	0.172	
14	-0.081	0.001	16.039	0.189	
15	0.089	0.117	17.020	0.198	
16	0.097	0.024	18.210	0.197	
17	0.023	-0.058	18.278	0.248	
18	-0.001	0.029	18.278	0.308	
19	-0.146	-0.079	21.026	0.225	
20	-0.064	-0.010	21.566	0.252	
21	0.069	0.009	22.203	0.274	
22	0.034	-0.041	22.361	0.321	
23	-0.039	-0.018	22.569	0.367	
24	-0.014	0.052	22.596	0.425	
25	-0.103	-0.075	24.076	0.400	
26	-0.039	-0.061	24.294	0.445	
27	0.101	0.063	25.751	0.421	
28	-0.016	-0.036	25.790	0.475	
29	-0.041	-0.001	26.041	0.516	
30	-0.014	0.012	26.071	0.569	
31	0.007	0.027	26.079	0.621	

Fig: 3.4 Sample ACF and PACF values of residuals of

**Model2**

In order to check normality of residuals, Kurtosis, skewness and Jarque-Bera statistic are used. As shown in the Figure 3.5 it is clear that Skewness is 0.01, Kurtosis is 3.39 and Jarque-Bera statistic is 0.683 with P value 0.71 (> 0.05)



**Fig: 3.5 Histogram of residuals of model 2**

The Lagrange Multiplier(LM) test has provided a standard means of testing parametric restrictions for a variety of models. Serial Correlation occurs in time-series studies when the errors associated with a given time period. Figure 3.5 Shows the non Serial Correlation of residuals of model 2 with LM test results of probability values for each term. All probability values are greater than 5% of significant level showed rejecting the alternative hypothesis  $H_2$ .

**Breusch-Godfrey Serial Correlation LM Test:**

F-statistic	1.868126	Probability	0.159762
Obs*R-squared	3.741020	Probability	0.154045

**Test Equation:**

Dependent Variable: RESID

Method: Least Squares

Date: 04/17/17 Time: 13:53

Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(3)	-0.003750	0.046138	-0.081288	0.9354
MA(3)	0.004607	0.044584	0.103341	0.9179
RESID(-1)	0.179282	0.099827	1.795921	0.0755
RESID(-2)	-0.099423	0.100658	-0.987736	0.3257
R-squared	0.035971	Mean dependent var		-0.000269
Adjusted R-squared	0.007050	S.D. dependent var		0.039294
S.E. of regression	0.039155	Akaike info criterion		-3.604858
Sum squared resid	0.153314	Schwarz criterion		-3.503151
Log likelihood	191.4526	Durbin-Watson stat		2.004316

**Fig: 3.6 Breusch-Godfrey Serial Correlation LM Test for residuals of model 2**

The presence of heteroscedasticity can validate by statistical tests. Here use Whit's general heteroscedasticity test (The White Test). The probability values are greater than the 5% of significance level which means that the null hypothesis  $H_0$  can be accepted. In other words no heteroscedasticity appears among residuals that are they have non constant variance.

**ARCH Test:**

F-statistic	0.533419	Probability	0.46684
Obs*R-squared	0.541124	Probability	0.461967

**Test Equation:**

Dependent Variable: RESID^2

Method: Least Squares

Date: 04/17/17 Time: 13:38

Sample (adjusted): 6 108

Included observations: 103 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001650	0.000281	5.863279	0.0000
RESID^2(-1)	-0.072570	0.099363	-0.730355	0.4669
R-squared	0.005254	Mean dependent var		0.001538
Adjusted R-squared	-0.004595	S.D. dependent var		0.002388
S.E. of regression	0.002394	Akaike info criterion		-9.212568
Sum squared resid	0.000579	Schwarz criterion		-9.161408
Log likelihood	476.4472	F-statistic		0.533419
Durbin-Watson stat	1.994989	Prob(F-statistic)		0.466864

**Fig: 3.7 Shows the Heteroscedasticity of residuals of model 2 of gold price.**

The careful investigation from the various Tests as mentioned above and Histogram of standard residuals in the fitted model 2 (above in Figure 3.5) infers that standard errors are roughly constant in its mean and variance is constant.

To investigate further whether there are any correlations between successive forecast errors, we will plot the correlogram (ACF) and partial correlogram (PACF) of the forecast errors. Following Figure 3.4 represents ACF and PACF of the forecast errors.

It is clearly evident from the ACF plot above that none of the autocorrelation coefficients between lag 1 and 20 are breaching the significant limits i.e. all the ACF values are well within the significant bounds.

Fitted model equation

$$(1 - B)(1 - \alpha B^3) \ln X_t = (1 - \beta B^3) e_t$$

$$\ln X_t = \ln X_{t-1} + 0.91 \ln X_{t-3} - 0.91 \ln X_{t-4}$$

$$= 0.94 e_{t-3} + e_t$$

**Forecasting and Model Accuracy**

**Table 4.4: The Forecast gold prices and Error Percentages**

Month	Forecast	Actual	Error	Error %
Jan2016	39572	40631	1058	0.026
Feb2016	39635	44424	4788	0.07
Mar 2016	42831	46153	3321	0.071

Future gold prices are estimated using the above fitted model the calculated Mean Absolute Percentage Error (MAPE) is equal to 6.37% for this fitted ARIMA model.

**Discussion**

A Unit root test was applied to the monthly gold prices it indicates the gold price series is non stationary. After the test of stationary, the test results of ADF and PP test conclude the data series is stationary at the 1st difference.

E-views software is used for fitting the coefficient of the model and after residual analysis the model selected is ARIMA with terms AR(3) and MA(3). Mean Absolute Percentage Error(MAPE) is used to measure forecasting accuracy.

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# ANATOMICAL VARIATIONS OF THE VESSELS IN THE FEMORAL TRIANGLE - A CASE REPORT

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**Abstract** - The femoral triangle is an important site for various clinical procedures. A sound knowledge about the anatomical variations of femoral vessels and their branches in the femoral triangle is important to prevent inadvertent damage to these vessels during surgical procedures and for successful arterial and venous cannulation for various purposes.

This case report describes the clinically important abnormal vascular patterns of the left femoral region of a middle aged Sri Lankan man observed during routine dissection. Profundafemoris artery originated

1 cm below the inguinal ligament from the lateral aspect of the common femoral artery at a higher level than that documented in the standard text books and in most of the previous studies. Subsequently femoral artery crossed superficially over the femoral vein and the femoral vein was lying deep to the femoral artery in most part of the femoral triangle.

The profunda femoral vein drained into the femoral vein as described in the text books nearly 3 - 4 cm below the inguinal ligament. Medial and lateral circumflex femoral arteries originated from profundafemoris artery.

Even though the variations are mostly incidental findings and being of general anatomical interest, knowledge of these variations appears to be mandatory for planning surgery and vascular interventions. It also serves as a reminder that constant vascular landmarks can occasionally be subject to marked variability. Ultrasonography should be used particularly for more difficult femoral vascular access.

**Key Words** - Femoral triangle, femoral artery, femoral vein, profundafemoris artery

## I. INTRODUCTION

Knowledge of normal anatomy and its variants is vital for safe surgical practice. The femoral artery and vein in the femoral triangle are utilized for various clinical procedures. Complications may arise from accidental puncture of the neighbouring artery or vein.

Anatomy text books state femoral artery lies between the femoral vein and femoral nerve in the base of the femoral triangle. The femoral vein usually crosses the femoral artery near the apex of the femoral triangle and lies posterior to it at its apex, 10 cm below the inguinal ligament (Sinnatamby C.S, 2011; (Strandring 2016). In the vascular surgical literature, the femoral artery above the origin of the profunda branch (deep femoral artery) is termed the common femoral artery, and the vessel below the profunda branch is the superficial femoral artery (Hughes et al, 2000). Profundafemoris artery which supplies the deep structures of the thigh and femur arises from the lateral side of the femoral artery about 3-4 cm distal to inguinal ligament (Sinnatamby C.S, 2011; (StrandringS. (ed.),2016).

We report the case of a high origin of profundafemoris artery and abnormal relation of femoral artery and vein within the femoral triangle. Aim of this study is to discuss normal anatomy and the possible variation of femoral vessels and highlight its clinical significance with relevant review of literature



## II. METHODOLOGY

The present report describes an abnormal relationship between femoral vessels and high origin of profundafemoris (PFA) artery from the femoral artery in the left lower limb of a formaldehyde preserved cadaver of a middle-aged Sri Lankan man in a routine dissection for undergraduate teaching.

During the dissection, the skin from the front of thigh was incised and reflected followed by the superficial fascia. The great saphenous vein and superficial inguinal lymph nodes were identified and the fascia lata was incised thus exposing the femoral triangle with intact inguinal ligament. The femoral sheath was identified and dissected thus exposing the contents of femoral triangle. The arrangement of structures within the triangle was studied.

## III. RESULTS AND DISCUSSION

In the left femoral triangle, the femoral vein was medial to the femoral artery at the base of the triangle. The profundafemoris artery was arising from lateral aspect of femoral artery just 1cm distal to the lower border of the inguinal ligament (Fig 1). The femoral artery passed superficially and medially over the femoral vein, such that the artery was lying superficial and slightly medial to the vein in the rest of the triangle (Fig 2). The profunda femoral vein drained into the femoral vein as described in the text books nearly 3 cm below the inguinal ligament (Fig 2). Medial circumflex and lateral circumflex arteries were originated from profundafemoris artery as usual. The femoral nerve and its branches maintained a normal relationship with the vessels.

According to the literature femoral vein lies medial to the femoral artery in the base of the femoral triangle and it maintain this side by side relationship in the major part of the triangle. The vein lies behind the artery at or near the apex of the femoral triangle. Femoral vein catheterization is necessary when there is no visible peripheral vein for cannulation or when rapid access to a large vein is needed (Bandyopadhyay et al, 2010). In this case the femoral artery crossed the femoral vein superficially in the proximal part of the femoral triangle and the femoral vein was lying deep to the femoral artery in the major part of the femoral triangle. In a study of 35 cadavers, the average distance from the inguinal ligament to where the vein starts to pass behind the artery was 6.6 cm and the measurement was less than 4 cm in three instances (Bosch

et al 1950). In an ultrasonographic study of 50 patients done by Hughes et al (2000) femoral artery was seen frequently overlapping the femoral vein. Moreover, the degree of overlap increases as the vessel descend distally towards the knee but overlapping of femoral artery and vein was not seen in any of the cases. They also observed that at the level of inguinal ligament in 72 % of the patients on the right side and 59 % of the patients on the left side the femoral artery and vein were side by side with vein medial to the artery. In the remaining cases there was partial overlap between the artery and vein.

Four centimeters below the ligament there was some degree of overlap in all the patients and in 50 % of them there was complete overlap. They concluded that side by side relationship of the artery and vein is commonest close to the inguinal ligament and to avoid damage to the neighbouring vessel, percutaneous access should be undertaken just below the inguinal ligament. But Bandyopadhyay et al (2010) reported a case of femoral artery crossing the femoral vein just deep to the inguinal ligament and it was lying superficial to the artery at the base of the femoral triangle.

According to Sinnatamby C.S, (2011), profundafemoris artery originate 3 - 4 cm distal to the midpoint of the inguinal ligament. This present case showed that profundafemoris artery originated from the lateral aspect of the common femoral artery 1 cm distal to the midpoint of inguinal ligament. A spectrum of variation in origin of PFA has been reported. Teli et al (2015) reported a similar case, where the PFA originated 1 cm distal to the inguinal ligament from the lateral aspect of the femoral artery. Bandyopadhyay et al (2010) reported a case, where the PFA originated deep to the inguinal ligament in a 42 year old Indian man. Similarly PFA originating from the lower border of inguinal ligament from the lateral aspect of the femoral artery was found in a case reported by Kumar et al (2011). In a Sri Lankan study on 26 femoral triangles by Samarawickram et al (2009) found that PFA origin vary from 3 - 7cm from midpoint of inguinal ligament with a mean value of 5cm, which is higher than that reported in standard text books and the literature. They also added in most of the time PFA on left side tend to originate from a point proximal to that of origin on the right side. A study of PFA by Prakash et al (2010) in Indian population revealed PFA originated from proximal 3rd in 29, middle 3rd in 25 and distal 3rd of femoral triangle in 10 out of 64 lower limbs studied.

The distance between midpoint of inguinal ligament and

origin of PFA is clinically important. It enables to identify the correct site of making incision for surgical exposure of the junction of femoral artery and profundafemorisartery (Kumar et al, 2011; Teli et al, 2015).

The common femoral artery is usually the site of choice for arterial puncture. Judkins technique for left heart catheterization is undertaken where femoral artery is approached by puncturing the vessel 1 to 3 cm below the inguinal ligament (Teli et al, 2015). Shorter the distance of origin of PFA from femoral artery leads to high risk of damaging it. Knowledge of the site of origin of PFA helps in avoiding iatrogenic femoralarteriovenous fistula and severe secondary haemorrhage while performing femoral artery puncture.

Pseudoaneurysms can occur when the puncture site is either at PFA or femoral artery distal to the origin of the PFA (Hughes et al, 2000; Kumar et al, 2011; Teli et al, 2015).Therefore, cannulation of the femoral artery should be done close to the inguinal ligament as possible to prevent inadvertent cannulation of PFA or superficial femoral artery (Hughes et al, 2000).

Teli et al, (2015) also commented that the high origin of PFA can cause problem in procedures like venous puncture and femoral nerve blocks, because of close relationship of vessels and nerve in femoral triangle.

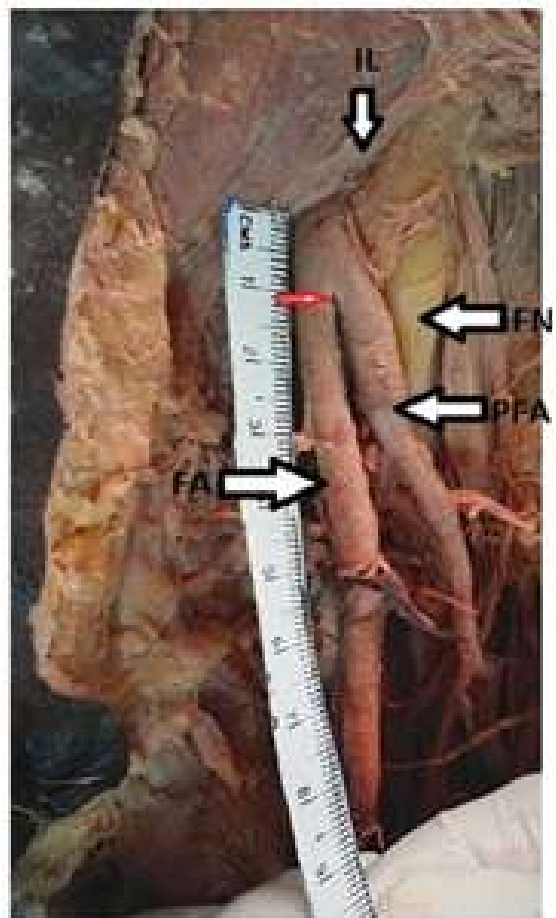
Samarawickrama et al (2009) stated that PFA commonly originate (46 %) from the posterior aspect of the femoral artery, posterolateral in 30 % and lateral in 23 % (in 6 out of 26).

This present case showed a lateral origin of PFA from the common femoral artery.Kumar et al (2011) also pointed out that the PFA originate from the lateral aspect of the femoral artery when its origin is close to the inguinal ligament. The direction of origin of PFA is important in catheter application, in making flaps with pedicles in reconstructive surgery and bypass procedures made to supply the lower extremity (Samarawickrama et al, 2009; Kumar et al, 2011)

In the present case both medial and lateralcircumflex femoral arteries originated from the PFA, as described in the standard text books (Sinnatamby C.S, 2011; Standing S. (ed.),2016). Perera (1995) had studied the variability of the level of origin of the PFA in relation to the different pattern of origin of the circumflex femoral arteries in 124 femoral triangles of SriLankan cadavers.

Accordingly in 'group A', where the mean distance of origin of PFA was 3.43 cm from inguinal ligament, inwhich case both the medial and lateral circumflex femoral arteries originated from the PFA.

In 'group B' where the mean distance of origin of PFA was 4.21 cm, either one or both circumflex femoral arteries originated from the common femoral artery instead of from PFA. He concluded that site of origin of circumflex femoral vessels depend on the level of origin of PFAfrom femoral artery and when it migrates distally from inguinal ligament either one or both circumflex femoral arteries originated from the common femoral artery instead of from PFA.



**Figure1: Showing ProfundaFemoris Artery [PFA] from lateral aspect of femoral artery (FA) 1 cm distal to inguinal ligament at the mid inguinal point [IL]. FN= Femoral nerve**



**Figure 2: Showing the crossing of femoral artery (FA) over femoral vein (FV) at a higher level and profunda femoris vein (PFV) draining into femoral vein at a lower level than the origin of profunda femoris artery (PFA). FT – Femoral triangle**

Previous documented studies also commented that the diameter of PFA decreases as the site of its origin becomes more distal from the inguinal ligament. The anatomical knowledge of the relationship of femoral vessels in femoral triangle, site and direction of origin of PFA and the diameter of PFA is needed for the safe medical and surgical practices. It prevents the necrosis of flap, when used in plastic and reconstructive surgery (Prakash et al., 2010; Kumar et al 2011).

#### IV. CONCLUSION

Even though the variations in femoral triangle are mostly incidental findings, knowledge of these variations appears to be mandatory for planning the surgery and determining the optimum site for vascular interventions. It will reduce the complication rates of blind techniques used to cannulate femoral artery and femoral vein. Ultrasound guidance of surgical intervention reduces the incidence of complications.

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# DETERMINATION OF *IN VITRO* ANTIMICROBIAL ACTIVITY OF SELECTED MARINE SPONGES FOUND IN SRI LANKA

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**Abstract** - Indiscriminate use of antibiotics leads to drug resistance in microorganisms. Therefore, discovery of new molecules to challenge the drug resistance is critically important. Sponges have developed efficient defense mechanisms which largely depend on the production of chemical compounds against foreign attackers. The aim of this work is to study the antimicrobial activities of *Clathria rugosa*, *Clathria foliacea*, *Acanthella acuta* and *Antho dichotoma*, collected from Dehiwala, Sri Lanka, against ten human pathogens and to separate and study the active ingredients using Bioautographic TLC assay. Mixture of methanolic and dichloromethane extracts of all four sponges were prepared using cold maceration technique. Using the standard disc diffusion method, extracts were tested against five Gram negative bacteria which includes *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Proteus mirabilis*, *Salmonella sp.* and *Escherichia coli*, three Gram positive bacteria which includes *Staphylococcus aureus*, Methicillin Resistant *Staphylococcus aureus* (MRSA) and *Staphylococcus saprophyticus* and two fungal species namely *Candida albicans* and *Aspergillus niger*. Out of the sponges tested, only *C. foliacea* was active against *S. aureus* (Inhibition Zone Diameter = 11.7 mm) and MRSA (IZD= 9.0 mm). *A. dichotoma* was active against *S. aureus* (IZD = 9.0 mm), MRSA (IZD = 10.0 mm) and *C. albicans* (IZD = 13.0 mm). All Gram-negative bacteria, *S. saprophyticus* and *A. niger* have shown resistance to extracts of all four sponges. The best separation in TLC was observed with a mixture of Hexane, Toluene, Dichloromethane, Diethyl Ether, Methanol and Water mixed in a ratio of 2: 0.05: 0.6: 0.3: 0.1: 0.002. Among the 12 spots of *A. dichotoma*, visualized under UV light, six spots inhibited the growth of MRSA and all the spots have shown the antimicrobial activity against *C. albicans* in TLC bioautography. Three out of seven visualized spots of *C. foliacea* were

active against MRSA. Among the four sponges studied, *A. dichotoma* showed higher antimicrobial activity in terms of inhibition of bacterial growth, then number of microbial species inhibited as well as higher number of antimicrobial compounds. None of sponges tested were active against Gram negative bacteria in the microbial panel used. *S. aureus* was the most susceptible pathogen among the tested microorganisms. Even though, *S. aureus* and MRSA were susceptible for two sponge extracts, *S. saprophyticus* has shown resistance for all the sponge extracts tested.

**Keywords** - Sponge, Antimicrobial activity, Cold maceration, TLC bioautography

## I. INTRODUCTION

Oceans cover more than 70% of the earth's surface and by volume it represents more than 95% of the biosphere. Still it comprises unexplored mysteries as it is a hard attempt to discover them. Sponges are such mysterious organisms where many of their defense mechanisms are still unknown.

### A. What are Sponges?

Sponges are multicellular organisms belonging to Kingdom Animalia, Phylum Porifera. The Phylum comprises several extant classes, i.e. Calcarea, Hexactinellida, Demospongiae and one fossil class, Archaeocyatha, 7 subclasses, 25 orders, 127 families and 682 genera and approximately 8300 species are currently recognized (Hooper et al., 2004). Sponges are aquatic species. Majority of them are found in marine environments and are important members of reef

ecosystems, while minority found in fresh water habitats. Their cells are embedded in a gelatinous matrix and are arranged around a system of water canals. Therefore the body is porous in nature.

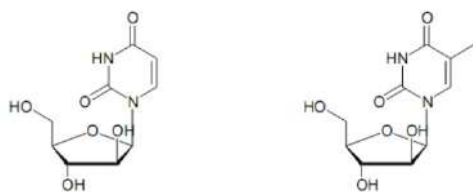
They do not have organs or true tissues. These are sessile filter feeders, which have developed a number of efficient defense mechanisms largely depend on the production of chemical compounds against foreign attackers such as viruses, bacteria, or eukaryotic predators (Bacuset al., 1974). Except for that, secondary metabolites can be produced by sponge associates, like bacteria and fungi (Thakur et al., 2003). These secondary metabolites are also involved in competition for space, providing protection from ultraviolet light etc. Most of the bioactive components of marine sponges are still to be identified.

### B. Theoretical and Historical Background of Sponges in the Field of Medicine

Usage of sponges for medicinal purposes has a long history. Approximately 400 BC, Hippocrates recommended to dress soldiers' wounds with certain sponges since they had antibiotic effects. (Riddle 1987).

Marine sponges are known to be a rich source of pharmacologically active metabolites. So far many such compounds with potential biomedical application have been isolated. These include proteins with hemolytic activity, hemagglutinin, compounds that express antibacterial, antifungal, antiviral, anticancer activities etc.

The first influential finding of bioactive compounds from sponges was the isolation and, identification of arabinose containing bioactive nucleosides namely, spongouridine and spongothymidine from *Tethya crypta* (Caribbean sponge) in early 1950s by Bergmann (Bhakuni et al., 2005)



Spongouridine

Spongothymidine

**Figure 01: Arabinose containing bioactive nucleosides (Image source: <http://rushim.ru/books/biochemie/bioactive-marine-natural-products.pdf>)**

In many studies, secondary metabolites of sponges with such activities have been identified. Examples for secondary metabolites are calyculins from *Discodermia calyx* (Kato et al., 1986), discodermolide from *Discodermia dissolute* (Gunasekara et al., 1990), latrunculins from *Latrunculia magnifica* (Spector et al., 1983), spongistatins from *Spongia sp.* and *Spirastrella sp.* (Petit et al., 1994). These are cytotoxic and inhibit cell proliferation and therefore have the potential to be used as chemotherapeutics.

In the study of biological activities of aqueous and organic extracts from tropical marine sponges, Kristina Sepčić and colleagues, (2010) found that almost all the samples were able to prevent the growth of at least one bacterial strain. Many inhibited the growth of Gram positive bacteria, but a few were active against Gram negative bacteria. The extracts that showed considerable activity towards Gram negative strain were those from *Topsentia ophiraphidites* and *Aplysina archeri*.

The strongest antimicrobial activity was found in the organic extracts of *Ircinia* and *Verongula*. Brominated compounds isolated from marine organisms have shown a broad spectrum of antimicrobial activity (Bhakuni et al., 2005). But most of them are toxic. Aerothionin, aerophobin-2, aplysinamisin-1, isofistularin-3 from *Aplysiaaerophoba* and *A. cavernicola* (Thoms et al., 2004) are such compounds.

However still the antimicrobial activities of sponges against bacterial and fungal diseases is little known and there are no antimicrobial compounds from marine sources have yet made it beyond the discovery phase into preclinical phase (Newman et al., 2016), mostly because of their toxicity (Bhakuni et al., 2005).

### C. Objectives

The aim of this work is to study the antimicrobial activities of *Clathria rugosa*, *Clathria foliacea*, *Acanthella acuta* and *Antho dichotoma*, against ten human pathogens and to separate and study the active ingredients using bioauthographic TLC assay (Hamburger et al., 1987).

## II. MATERIALS

### A. Samples

Samples of the four sponges were collected from Dehiwala Sri Lanka.



**Plate 01: *Clathria rugosa***



**Plate 02: *Clathria foliacea***



**Plate 03: *Acanthella acuta***



**Plate 04: *Antho dichotoma***

### **B. Microbial panel**

*Staphylococcus aureus*, *Salmonella sp.* and *E. coli* were obtained from National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15. *Klebsiella pneumoniae*, *Pseudomonas aerogenosa*, *Proteus mirabilis*, *Candida albicans*, *Aspergillus niger*, Methicillin Resistant *Staphylococcus aureus* (MRSA), *Staphylococcus saprophyticus* were obtained from Faculty of Medicine, University of Peradeniya.

Bacteria were cultured in nutrient agar and fungi were cultured in potato dextrose agar. The stock cultures were maintained at 40C.

## **III. METHODS**

### **A. Preparation of extracts**

Cold maceration technique was used to prepare the extracts. First the samples were kept outside for several minutes for the water to drain. Approximately 20 g wet weight of each sponge sample was chopped and then separately added to 50 ml conical flasks containing 30 ml of methanol in each. Then each flask was closed with polythene. After 24 hours at room temperature the sponge tissues were squeezed by pressing it in between glass funnel and spatula to remove soaked solvent. All the solutions were filtered using Whatman No.01 filter papers separately.

Using the same method Dichloromethane extracts were also prepared using already methanol extracted, filtered, sponge tissues. The two extracts were mixed and the solvent mixture was evaporated at 400C under vacuum with the use of rotary evaporator. The resulted solid was dried in a vacuum desiccator. The solid was weighed.

Then it was re-dissolved in a known amount of methanol, dichloromethane solvent mixture to create a solution with 0.05 g cm<sup>-3</sup> concentration.

**Table 01: Volume of the solvent mixture added to prepare 0.05 g cm<sup>-3</sup> concentrated extracts**

Sample	Wet drained weight (g)	Weight of the solid after evaporating the solvent (mg)	Volume of the solvent mixture added to prepare 0.05 g cm <sup>-3</sup> (cm <sup>3</sup> )
<i>Clathria rugosa</i>	20.85	399.6	08.0
<i>Clathria foliacea</i>	20.20	646.9	12.9
<i>Acanthella acuta</i>	18.22	285.4	05.7
<i>Antho dichotoma</i>	20.17	273.3	05.5

## B. Antimicrobial assay

Antibacterial activity was tested using the standard disc diffusion method.

### 1) Preparation of 0.5 McFarland Standards:

Aqueous solutions of BaCl<sub>2</sub> (0.5 mL of 0.048 mol dm<sup>-3</sup>) and 9.95 mL of 0.18 mol dm<sup>-3</sup> H<sub>2</sub>SO<sub>4</sub> (aq) was mixed to prepare the McFarland standard. T 70 UV/VIS Spectrometer was used to measure the optical density. Optical density (OD) of a 0.5 McFarland standard at 530 nm (OD<sub>530</sub>) ranges between 0.11 and 0.14. The prepared McFarland standard was stored at 4°C.

### 2) Preparation of inoculums:

At least four morphologically similar colonies were transferred into 5 mL of sterile distilled water. Then the visible turbidity was adjusted by adding distilled water or adding more colonies until it is equal to 0.5 McFarland standard (0.5 McFarland standard ≈ 1.5 × 10<sup>8</sup> CFU/mL).

### 3) Preparation of agar plates:

*S. aureus*, *Salmonella sp.*, *E. coli*, *K. pneumoniae*, *P. aerogenosa*, *P. mirabilis*, *C. albicans*, Methicillin Resistant *S. aureus* (MRSA), *S. saprophyticus* lawns were prepared by spreading the bacterial suspension separately (correspondent of 0.5 McFarland Standard) on Nutrient Agar plates using a sterilized cotton swab. *Aspergillus*

*niger* was streaked evenly on Potato Dextrose Agar plates. The distance between streaks is about 7 mm.

### 4) Application of sponge extracts:

Dried sterile (Whatman No 01) filter paper discs with 5 mm diameter were prepared using approximately 10 µL of 0.1 g cm<sup>-3</sup> sponge extracts separately. Five different discs were placed on each plate. Entire assay was carried out in triplicate.

### 5) Control discs:

Dried sterile paper discs were prepared using the two solvents, methanol and dichloromethane separately to determine whether there could be any effect of residues of the solvents with antimicrobial activity.

### 6) Incubation conditions:

The subjective microorganisms are human pathogens. Therefore, all the plates were incubated at 37°C for about 24 hours.

### 7) Selection of sponges with antimicrobial activity:

Sponges that resulted in inhibition zones were noted and the diameter of the inhibition zones were measured and tabulated.

## C. TLC analysis of sponge extracts

Pre-coated (MERCK) analytical silica gel G60 F254 A1 sheets with a fluorescence indicator were used for Thin Layer Chromatography.

### 1) Selection of a proper mobile phase for TLC analysis:

Toluene, hexane, diethyl ether, methanol, dichloromethane and water were mixed in different ratios to find a proper mobile phase.

### 2) Application of Extracts:

4 µL of 0.1 g cm<sup>-3</sup> sponge extracts which resulted in antimicrobial activity in previous assay was applied on TLC plates. The TLC plates were pre-heated at 180°C for 1 hour to sterilize.

### 3) Development of Chromatograms:

The plates were developed in a pre-saturated chamber using Hexane, Toluene, Dichloromethane, Diethyl Ether,

Methanol and Water (Mixed in a ratio of 2: 0.05: 0.6: 0.3: 0.1: 0.002) solvent system.

4) Visualization:

Separated compounds were visualized under (254 nm and 365 nm) UV light. The separated compounds were marked and the R<sub>f</sub> values were calculated and tabulated.

$$\text{Retardation factor (R}_f\text{)} = \frac{\text{Distance from starting front to the compound}}{\text{Distance from starting front to solvent front}}$$

5) Selection of compounds with antimicrobial activity:

The developed chromatograms were placed facing up in 16 cm diameter Petri dishes. Nutrient agar medium mixed with the susceptible microorganisms were poured on the TLC plates. Plates were incubated at 37°C for about 24 hours. Inhibition zones were visualized by adding hydrogen peroxide reagent. Marked the compounds with inhibitory activities and their R<sub>f</sub> values were noted. Entire assay was carried out in triplicate.

IV. RESULTS AND DISCUSSION

Indiscriminate use of antibiotics leads to drug resistance in microorganisms. Discovery of new molecules to challenge the drug resistance is critically important. Oceans which cover more than 70% of the earths’ surface still comprise unexplored mysteries as it is a hard attempt to discover them. Sponges are such mysterious organisms where many of their defense mechanisms are still unknown. Bioactivity of marine sponges against bacterial and fungal diseases is little known. Therefore, aim of this work is to study natural antibiotics from marine sponges.

Prior to extraction, it is essential to freeze the dead sponges to prevent possible contaminations. If the contaminating microorganism has an antimicrobial activity, it would result false positives. And it is not advisable to wash sponges using distilled water. Some compounds dissolve even in salt saturated water when the sponge is dead. Washing with distilled water will remove valuable secondary metabolites which are in very small quantities. Cold maceration technique is advisable to extract compounds which are unknown, as they may be

intolerant to higher temperatures. Methanol is a polar solvent with the polarity index of 5.1. Polar compounds show higher affinity to polar solvents whereas non-polar compounds show higher affinity to non-polar solvents like dichloromethane which has the polarity index of 3.1.

One of the biggest problems with these extracts is that they contain a significant amount of water. The boiling point of water is 1000C, where methanol and dichloromethane has lower boiling points, 650C and 400C respectively. Bringing the temperature of the solvents to a higher temperature in order to evaporate the solvent would damage the thermo labile compounds. Rotary evaporator is used to bring down the boiling temperatures of the solvents under vacuum. This also will reduce the possible damages to the thermo labile compounds.

In the in vitro antimicrobial assay of methanol, dichloromethane extracts of four sponges were tested against *S. aureus*, *Salmonella sp.*, *E. coli*, *K. pneumoniae*, *P. aeruginosa*, *P. mirabilis*, *C. albicans*, *A. niger*, MRSA and *S. saprophyticus* and their potency was measured as diameter of the inhibition zone (Table 02).

A. Antimicrobial activities

*Salmonella sp.*, *E. coli*, *K. pneumoniae*, *P. aeruginosa*, *P. mirabilis*, *S. saprophyticus* and *A. niger* were resistant to extracts of all sponges. In the study of Biological Activities of Aqueous and Organic Extracts from Tropical Marine Sponges, Sepčić and colleagues, (2010) found that many inhibited the growth of Gram positive bacteria, but a few were active against Gram negative bacteria. The only extracts that showed considerable activity towards Gram negative strain in their study were those from *Topsentia ophiraphidites* and *Aplysina archeri*.

Table 02: Average diameters of inhibition zones in millimeters

Microorganism \ Test material	C. rugosaextract	C. foliaceaeextract	A. acutaextract	A. dichotomaextract	CH <sub>3</sub> OH added disc	CH <sub>2</sub> Cl <sub>2</sub> added disc
<i>S. aureus</i>	0.0	11.7	0.0	9.0	0.0	0.0
MRSA	0.0	9.0	0.0	10.0	0.0	0.0
<i>C. albicans</i>	0.0	0.0	0.0	13.0	0.0	0.0



*Clathria rugosa* and *Acanthella acuta* were not effective against any of the subjective microorganism. *Clathria foliacea* extract was active against *S. aureus* and MRSA. *Antho dichotoma* has shown the highest antimicrobial activity and it was active against *C. albicans*, *S. aureus* and MRSA. However in a certain study *Clathria indica* which is an Indian sponge has shown antibacterial activity against common and multi drug resistant *Salmonella typhi* and anti-fungal activity against *C. albicans* and *C. neoformans*. And it was ineffective against *E. coli*, *P. aeruginosa*, *Streptococcus pyogenes* and *S. aureus* (Ravichandran et al., 2011). In a similar study eleven Kalihinol compounds, which are multifunctional diterpenoid antibiotics, from two *Acanthella sp.* has shown antimicrobial activity against *S. aureus*, *Bacillus subtilis* and *C. albicans* (Clifford et al., 1987).

## B. Thin Layer Chromatography

Most appropriate mobile phase for Thin Layer Chromatography was a mixture of Hexane, Toluene, Dichloromethane, Diethyl Ether, Methanol and Water mixed in a ratio of 2: 0.05: 0.6: 0.3: 0.1: 0.002. In the antimicrobial assay of separated compounds it is better to use preparative grade TLC plates, where compound loading capacity is high, for a better detection of inhibition zones.

### 1) Developed Chromatograms:

Twelve different compounds of *A. dichotoma*, eight different compounds of *C. foliacea* were separated. The developed chromatograms were observed under 254 nm and 365 nm UV wave lengths. (Plate 06)

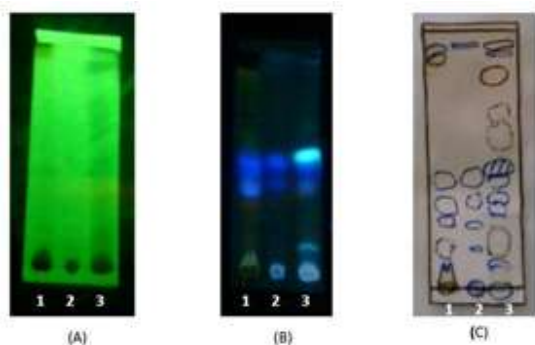


Plate 06: TLC of methanol, dichloromethane extract of *C. foliacea* (Track 01), *A. dichotoma* (Track 03) developed with Hexane, Toluene, Dichloromethane, Diethyl Ether, Methanol and Water (Mixed in a ratio of 2: 0.05: 0.6: 0.3: 0.1: 0.002) solvent system and visualized under (A) 254nm and (B) 365nm UV radiation (C) Diagram showing the separated compounds.

### 2) Antimicrobial activity of separated compounds:

Bio autography is a method to localize antimicrobial activity on a chromatogram in order to find new antibiotics. Here the antimicrobial compounds are transferred from the chromatographic layer to an inoculated agar layer through a diffusion process. But the diffusion rates of the compounds may be different. To minimize the problem it is recommended to mix the susceptible microorganisms with the growing medium. Any inhibition was not observed when the bacterial lawns are prepared on the surface of the medium. Inhibition zones were visualized by adding hydrogen peroxide reagent. Quickly, the compounds with inhibitory activities were marked before the foam cover the entire plate. The  $R_f$  values of the compounds were noted.

After the addition of Hydrogen peroxide, the inhibition zones on the TLC plates were clearly visualized. Three out of eight compounds (Table 04) of *C. foliacea* and six out of twelve compounds (Table 03) of *A. dichotoma* were active against MRSA (Plate 07). All the separated compounds (Table 03) of *A. dichotoma* have shown antimicrobial activity against *Candida albicans* (Plate 08).

Plate 07: Visualization of inhibition zones on MRSA cultured plates after the addition of Hydrogen peroxide.



(Track 1: *C. foliacea* extract and Track 2: *A. dichotoma* extract)

Plate 08: Visualization of inhibition zones on *Candida albicans* cultured plates after the addition of Hydrogen peroxide.



(Track 1 and Track 2: *A. dichotoma* extract)

**Table 03: Separated compounds of A. dichotomashowing antimicrobial activity.**

Microorganism Rf value	MRSA	C. albicans
0.00	+	+
0.10	+	+
0.16	+	+
0.30	-	+
0.34	-	+
0.41	-	+
0.45	-	+
0.59	+	+
0.68	+	+
0.84	-	+
0.91	-	+
0.94	+	+

**Table 04: Separated compounds of C. foliacea showing antimicrobial activity.**

Microorganism Rf value	MRSA
0.00	+
0.05	-
0.15	-
0.25	+
0.32	+
0.43	-
0.89	-
0.94	-

Antimicrobial assay against *S. aureus* could not accomplish due to the lack of time and lack of extractions prepared.

## V. CONCLUSION

*Antho dichotoma* is the most bioactive sponge in antimicrobial activity in terms of inhibition then number of microbial species inhibited as well as higher number of antimicrobial compounds.

None of sponges tested were active against the Gram negative bacteria in the microbial panel used. *S. aureus* was the most susceptible organism for the sponge extracts tested. Even though *S. aureus* and MRSA were susceptible for few sponge extracts, *S. saprophyticus* has shown resistance for all the sponge extracts used.

## VI. FUTURE PERSPECTIVES

More complete separation of extracts can be achieved by two dimensional (2D) development of TLC. The second development should be performed using a different mobile phase. Visualization methods should be improved for a better detection of inhibition zones on chromatograms. If there is a significant compound with such activities, it is worthy to elucidate the chemical structure, in order to synthesis an economical drug.

Methicillin Resistant *Staphylococcus aureus* (MRSA) is of major concern as it expresses resistance against commonly used antibiotics such as all penicillinase stable penicillins, macrolides, lincosamide, tetracyclines etc. Here are two sponges which comprises potential chemotherapeutic compounds against MRSA. The compounds should be tested for toxicity and side effects prior clinical trials.

A study should be done to verify that the compounds with antimicrobial activities are of microbial origin or sponge origin. If the compounds are of microbial origin, a separate study should be carried out isolating the symbiotic microorganisms and testing for their metabolites.

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# PROPENSITY OF ENDEMIC *Exacum* spp. (BINARA) AS AN ORNAMENTAL PLANT: A CASE STUDY AMONG AGRICULTURAL UNDERGRADUATES, UNIVERSITY OF RUHUNA, SRI LANKA

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**Abstract** - Introduction of new plants is critical to the survival and profitability of the floricultural industries. These provide a marketing edge and can offer real benefits to fulfill special floriculture needs. Present survey was conducted to observe the potential of endemic *Exacum* spp. (Binara) as an ornamental plant among younger generation. The sample was selected from undergraduate students (n=125), Faculty of Agriculture, University of Ruhuna, Sri Lanka. Semi-structured interviews were carried out among the undergraduates representing all districts of Sri Lanka using a pre-tested questionnaire and showing a specimen of Binara plant. Group discussions were conducted with randomly selected students; 5 students/ group. Data were analyzed descriptively and presented with appropriate descriptive tools. The survey revealed that lack of awareness about Binara plant among the university students (66%) in most of the Districts of Sri Lanka.

The results showed those respondents around 78% like to natural colour (blue-purple), actual flower size (50%), natural texture of flower petal (60%) and the height of the plant (70%) of the Binara flower. The respondents of 36% have not clear idea about vase-life of Binara flower. The respondents were more like to use Binara plant as potted plant (60%) than cut flower (40%). When considering the propagation of Binara, 58% respondents accept with propagation by seeds (58%) rather than asexual propagation (42%). However seed propagation of *Exacum* is hard in home level as its seeds are very small (110-140µm). Among vegetative propagation techniques, 68% respondents suggested to develop cutting than

layering (42%). Most of the respondents liked to use Binara plant as an ornamental plant and it was shown that the ornamental value of Binara flower will help to develop the floriculture industry.

**Key words** - *Exacum* spp., ornamental, propagation, vase-life

## I. INTRODUCTION

Ornamental plants play a fundamental part in the way humans interact with and modify the environment. Flower based production can be divided in to several forms cut flowers, cut foliage, pot plants (including pot-flower and pot-greens) and bedding/garden plants (Xia et al., 2006). These products are used for different decorative purposes such as floral arrangement, landscape gardening, indoor and outdoor decoration etc. Cut flowers are the dominant products in world floriculture industry. In floral arrangements may be composed of only flowers and or foliage or in combination with vegetables and fruits.

The floriculture is a dynamic sector where a wide range of products are considered. To stand the global competitiveness it is mandatory to introduce novelties into the market. Therefore, introduction of new ornamental crops into commercial production and mastering their production technology is an essential requirement for development of commercial horticulture. As a result of above reasons nowadays, thousands of varieties of cut-flowers, pot plants, hanging plants, bedding plants, shrubs, lawn and turf, ornamental tree and aquatic plants are available to the public. Scientific evidence show

commercial production of native ornamental plants can represent a way of ex-situ conservation of endangered plant species (Karlović, 2007).

Genetic engineering is providing a valuable means of expanding the floriculture gene pool by promoting the generation of new commercial varieties (Tanaka et al., 2005). Plant transformation technology (hereafter abbreviated to GM, or genetic modification) has been used to develop many varieties of crop plants, but only a few varieties of ornamental plants. These techniques are used for the color modification of flowers, fragrance modification, development of abiotic stress resistance plants, pest and disease resistance and to increase vase life. These techniques can also be used to manipulate form and architecture of plants and/or flowers (Chandler and Sanchez, 2012).

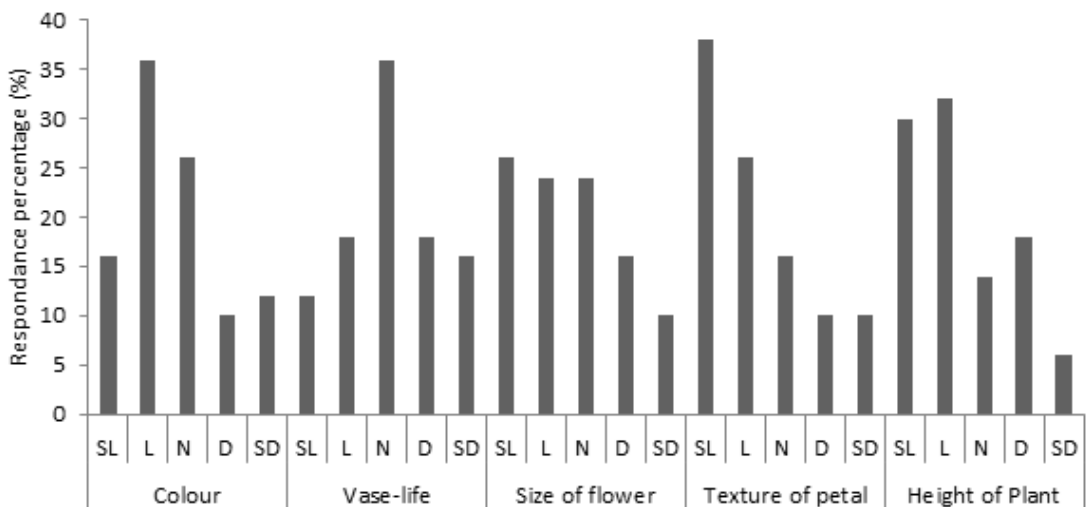
In the National Red List of Sri Lanka (2012), the *Exacum pedunculatum* is listed as critically endangered. Out of the eight species of *Exacum* found in Sri Lanka, four have been recognized as endangered and five as endemic (Risidra, 2015). The value of *Exacum* with colourful flowers in landscaping and in floriculture has not yet been recognized in Sri Lanka. As it is believed, the time has come to open up eyes to protect this valuable endemic plant species which is seriously threatened. So, this study was conducted to study the propensity towards endemic *Binara* as ornamental plant among younger generation.

## II. METHODOLOGY

A survey was carried out among the 125 undergraduate students in Faculty of Agriculture, University of Ruhuna, Sri Lanka, between in February and March in 2017. Focus-group discussions were carried out as groups, with purposely random sampled undergraduates representing all districts of Sri Lanka using a pre-tested structured questionnaire with specimen of *Binara* plant. Groups with five students for each 25 districts were gained. Data were analyzed descriptively and presented with appropriate descriptive tools.

## III. RESULTS AND DISCUSSION

The survey showed that around 66% students were not aware about *Exacum* (*Binara*) species which were similarly observed by Perera et al. (2016) among Sri Lankans. Respondents, who knew about *Binara* plant said that, in the past, *Binara* plants were observed frequently but now, they are rare to see (Perera et al., 2016). The survey was found that the respondents from Kilinochchi, Batticaloa and Vavuniya Districts are not familiar with the *Exacum* species because there are no cited evidences and their living areas are not the natural habitats of *Binara* being located in the dry zones in Sri Lanka. Respondents who live in Matale, Rathnapura, Monaragala, NuwaraEliya, Gampaha and Kalutara districts have some idea about *Binara* more than (20%), among above respondents in Matale district was the most (60%).



**Figure 1: The propensity towards ornamental characters of *Binara* (*Exacum* spp.) (SL, strongly like; L, like; N, neutral; D, dislike and SD, strongly dislike) (n=125).**

According to Figure 1 observations, around 78% liked the natural colour (blue-purple) of the Binara flower. Of the respondents 36% had no clear idea about vase-life of Binara flower and altogether it has neutral idea. More than 50% of respondents liked their actual flower size, When supposing the texture of flower petal, more than 60% of respondents liked its natural texture of flower petal. The height of the plant also fit to the respondents matching about more than 70%. The results showed that there were no relationship between gender and ornamental characters of Binara which were surveyed.

*Exacum ritigalensis* and *Exacum trinervium* contain about five to seven flowers per flower bunch. Around 80% of respondents liked having five to seven flowers per flower bunch. When considering about the export features and floriculture industry, respondents were more like to use Binara plant as potted plant (60%) than cut flower (40%). Sri Lankan Binara species has potential to develop as pot plants because the developed variety, such as Persian Violet (*Exacum affine*) which makes an excellent potted plant and a great choice for using as a table centerpiece in the world.

The survey showed that 60% among total respondents were not happy to change Binara plant flower colour, vase-life, size, texture of petal and plant height with modifications. For the popularization of the plant, propagation of the plant is very important. When considering the propagation of Binara, 58% respondents accept sexual propagation by seeds rather than asexual propagation (42%). But seed propagation of *Exacum* is difficult in home level because the size of the *Exacum* seeds ranges from 110-140  $\mu\text{m}$  (Robert, 1997). Among vegetative (asexual) propagation techniques, 68% respondents suggested to develop cutting propagation techniques than layering techniques (42%). To enhance the ornamental value of Binara flower, it should be concerned about value added products and flower preservation techniques and to improve simple and easy propagation methods. Binara plant is an annual plant and it causes to reduce its ornamental value because of their short life-span. When considering the above fact, some respondents suggested modifying Binara plant as perennial plant.

## IV. CONCLUSION

The most of the respondents agreed to accept Binara flower as an ornamental flower. It is revealed that the ornamental potential of Binara flower has an economical value rather than endemic value. In future Binara plant will help the development of the floriculture industry in Sri Lanka.

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# SLIPPAGE OF TRADITION AND CONVERSION INTO NEW TECHNOLOGY IN THE PADDY CULTIVATION IN MUTHUKANDIYA AREA

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**Abstract** - Rice consumption has become the no one food around the globe. In Sri Lanka, the paddy supply changes in different provinces and the districts. Presently, a competition in the paddy cultivation can be identified due to the use of new technology. At present, new genetic technological seeds and agrochemicals are being discovered for the paddy cultivation in Muthukandiya area. The farmers who live in Muthukandiya area, are facing difficult situations due to the application of both traditional paddy cultivation and new technology based paddy cultivation. The main objective of this research was to reveal the difference and the influence of the past traditional paddy cultivation and newly use technology based paddy cultivation in the Muthukandiyaarea.

To collect fundamental information according to the main points, questionnaire was given to the farmers who live in Muthukandiya area which is situated in Uva province, Monaragala district in Siyabalanduwa regional division. According to the collected information, hundred percent (100%) of the farmers ignored the traditional paddy cultivation and turned into the new technology based paddy cultivation.

Thirty five percent (35%) of the people live in Muthukandiya area, are suffering from the kidney deceases, heart attacks and weakness of the vision because the use of new technology methods for the paddy cultivation. After the analyzing the collected information, it is revealed that the problems they have to face because the traditional paddy cultivation was converted into the new technology based paddy cultivation.

**Key words** - Traditional, New technology, Agrochemical, Paddy cultivation, Influence

## I. INTRODUCTION

Sri Lankan farmers cultivate paddy according to the weather and climate conditions. Paddy cultivation became the number one position in the agricultural sector from the ancient times in Sri Lanka.

The large expansion of the paddy cultivation named first village and second village in the Muthukandiya area. Today, the farmers who live in this area do not use any traditional agricultural methods used in the paddy cultivation and also do not use traditional kind of seeds and the equipment, because they were Introduced to new hybrid seeds for cultivation and they have to use lot of chemical fertilizer to get great harvest.

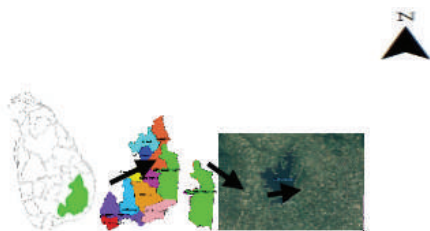
In ancient times, there were no need to use chemicals to get better harvest but nowadays it difficult to get better harvest in hybrid seeds without using the chemical fertilizer. The Department of Agriculture provides knowledge for the farmers in their day to day activities with rules and regulations but farmers go beyond the rules and regulations. Health organizations indicate that there are more than two hundred thousand (200,000) dangerous situations generated per year because of the use of chemical fertilizers in Sri Lanka. Because it is more expensive to use new technology for the paddy cultivation, sometimes loss is accounted which may contribute to the increase of suicide rate among farmers. Hence, this research was carried out to identify the influence to the

farmers and the people live in Muthukandiya area from the traditional paddy cultivation and new technology based paddy cultivation and to analyze the good and bad qualities generated in above two different cultivation methods.

## II. OBJECTIVE

The objectives of this research were to reveal the differences and influences of the past traditional paddy cultivation and newly used technology base paddy cultivation in this area and to reveal the health problems, good and bad effects of the past and newly used paddy cultivation methods.

### Study area



Source: www.google.com

## III. METHODOLOGY

Twenty-five [50] families living in Muthukandiya were selected using simple random sampling in first village (n=25) and second village (n=25) which is situated in Siyambalanda regional division.

**Table 01-Number of families selected for the research**

Secretariat Division	Grama Niladari Division	Population	Total Number of houses	Number of families selected of the research
Siyambalanda	122D Muthukandita	835	200	50

Source: resource profile [2017]

Interviews were done for the people in this area and. A questionnaire was used to assess the differences in the

paddy cultivation methods for the twenty five [25] percent people in this village. It shows the social, economic, Health and attitude of the traditional paddy cultivation in people in this area. Newspapers, magazines and journal articles were used as secondary data to collect information about study area and other related studies.

## IV. RESULT AND DISCUSSION

Traditional kinds of seeds and safty methods used in traditional paddy cultivation in muthukandiya area.

At the past, hundred percent (100%) of the farmers in Muthukandiya area used traditional paddy cultivation. In that area, there were not money expenses because they produced their own seeds. They used top of the productive seeds in the paddy crop as the seed-paddy. They used Kuruluthudu, Heeneti, Goonabaru, Suwandel, Duru wee, Kalu wee and Maawee as traditional seeds.

Following graphs shows the number of farmers use that different kinds of seeds. (Figure 1, Figure 2)



Figure 1

Sources :field study[2016/09/23]

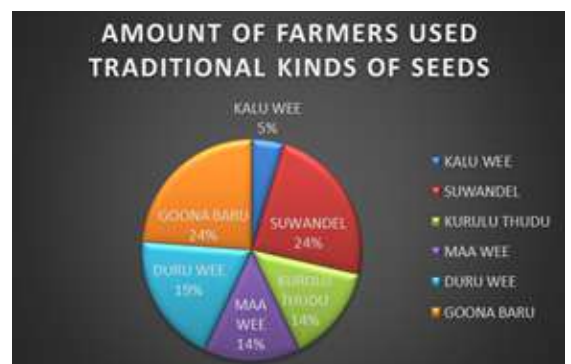


Figure 2

Source :field study[2016/09/23]



Farmers used above mentioned seeds and used rain water to their cultivation process. In traditional paddy cultivation, farmers did not use chemicals, insecticides and fertilizers.

Without adding those harmful chemicals, farmers easily gained better harvest. Farmers used different traditional methods like amulets and charms to protect their harvest from animals.

They used,

- Cover paddy field using rope to protect harvest from pigs.
- Charm the sand and spray it.
- Charm the oil and lighting the lamps.
- Kappuwalliya leaves juice mix with water and spray it in field.
- Planting the Marigold flowers near the paddy field.
- Kohomba leaves mix with baccy (tobacco) and spray it into the paddy field.

Farmers used above mentioned safety methods and it would not harm to their health. In traditional paddy cultivation, they cultivated once a year.

It named as “Mahakannaya”. Farmers said that they could get harvest within four or five months after the cultivation.

In this traditional paddy cultivation, they used Buffalos to thresh, Samanala hoc (Sinhala hoc), 9.9 hoc and Govileella as traditional equipment. Reaping hook, Maaralla and Boolaaththa were used to collect harvest. Farmers said that they have capabilities to start again traditional paddy cultivation without extra money.

**NEW TECHNOLOGY BASE PADDY CULTIVATION IN MUTHUKANDIYA AREA.**

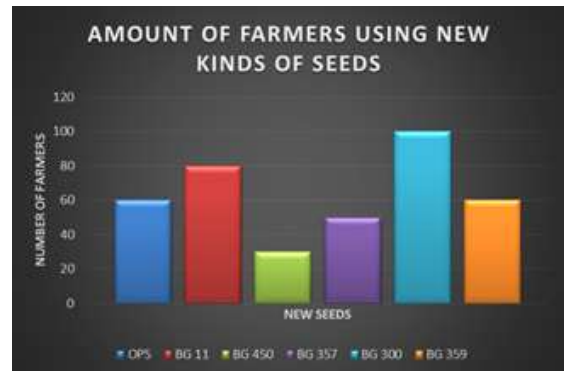
To achieve a great harvest, farmers shifted to the new technology base paddy cultivation. It introduced hybrid seeds for paddy cultivation. Hundred percent (100%) of farmers cultivated hybrid seeds in Muthukandiya area. They used only rain water method to cultivate paddy. They cultivated twice per year named as “Yala” and “Maha”. Among the study population farmers had to spend lot of money to buy seeds.

According to the new technology, farmers had to adjust the paddy field three times to get great harvest. Furrowing,

Puddling and Leveling the field were the three main activities. Farmers had to use special machines. Make the baulk using the Kokunagula (plough), puddling from the tractor and leveling from the mud board can be shown as examples.

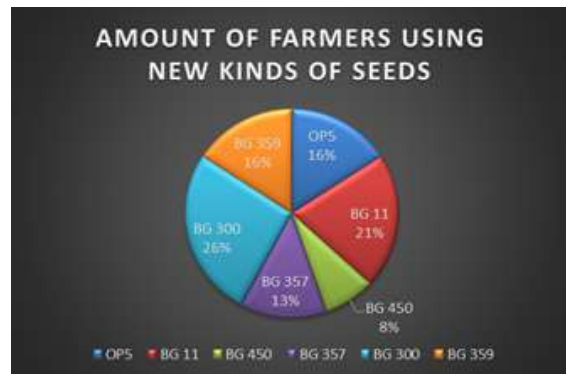
Farmers were using new kinds of seeds like OP5, BG11, BG450, BG357, BG300 and BG359 in this area.

Following graphs show the amount of farmers using new kinds of seeds. (Figure 3 and Figure 4)



**Figure 3**

Source :field study[2016/09/23]



**Figure 4**

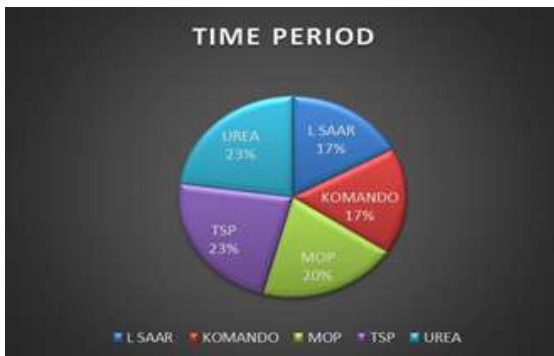
Source :field study[2016/09/23]

Farmers had to use chemicals to get great harvest from above mentioned seeds. Full destructive chemicals, half destructive chemicals, Weedicide, Fungicide and Insecticides were used as chemicals. L Saar, Komando, Mimik, Inoshaan, MOP, TSP and Urea are the some of the names of the chemicals.

Following graphs show the time period of collect harvest from using chemicals. (Figure 5 and Figure 6)



**Figure 5**  
Source :field study[2016/09/23]



**Figure 6**  
Source :field study[2016/09/23]

Following methods were used by the farmers in this area.

- Spraying the fertilizer into the field after one day of planting of paddy.
- Half destructive chemical named “34DPA” used within 10 days after the planting.
- Use Insecticide (Mimik) within one month to destroy worms in the field and use Weedicide (WiksUPER) within forty five (45) days.

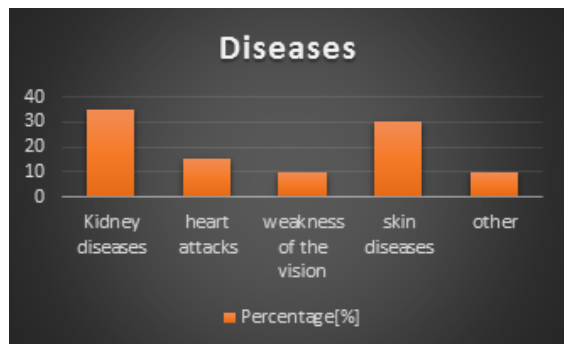
People in Muthukandiya area had to spend over fifty thousand rupees (Rs.50, 000) for one season when using the new technology for the paddy cultivation. Farmers had to take instructions from authorities to do their activities properly. They had to pay special attention to collect harvest at the right time and special machines were also used. Reaping hook is used to cut the paddy and Tsunami machine was used to thresh.

People in Muthukandiya area had to face lot of health hazards because of the new technology used in paddy cultivation. Kidney diseases, weakness of the vision, skin diseases, faintishness and heart attacks are name to few.

**Table 02-**

Diseases	Percentage[%]
Kidney diseases	35
heart attacks	15
weakness of the vision,	10
skin diseases	30
other	10

Source :field study[2016/09/23]



**Figure 7**  
Source :field study[2016/09/23]

Farmers had to spend about one hundred thousand rupees (Rs.100, 000) to cultivate one acre and also it gained about two hundred fifty thousand rupees (Rs.250, 000) as their profit. But, bad situation is farmers had to spend another money for transport paddy to paddy collecting centers. Finally, when calculating the profit, it was not enough for the farmers to continue their cultivation.

To earn beneficial profit and make healthy harvest,

- Increase farmers’ knowledge on the traditional paddy cultivation methods.
- It is useful to start knowledge sharing programmes to the problems arisen while using new technology based paddy cultivation. It can be arranged systematically by combining Agricultural Organizations and Health Organizations.
- Decrease the genetic technology seeds and promote traditional kinds of seeds.

- Use traditional fertilizer methods and use traditional safety methods for protect harvest.
- Prepare new rules and regulations for the paddy cultivation.

## CONCLUSION

There were no threats for health when using the Traditional paddy cultivation. But it was totally changed after converting to New technology based paddy cultivation. It is very harmful not only to the farmers who live in Muthukandiya area but also to the other people and consumers.

It is easier to use traditional cultivation methods and farmers did not use chemicals for their cultivation process. So, it makes trust among the consumers about their production. But today, farmers use genetic technological seeds and more chemicals to face competition in the market and to get great harvest.

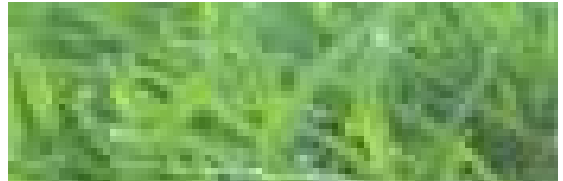
Specially, farmers do not follow safety methods when using weedicides and agrochemicals. So, they have to face lot of health hazard like kidney diseases, skin diseases, faintishness and weakness of the vision. Twenty two percent (22%) of families in this area faced the lot of problems due to the New technology based paddy cultivation.

When analyzing the collected information, bad effects generated by the New technology can be identified. Traditional paddy cultivation methods make favorable conditions to the society. Authorities have to be responsible to make decisions and regulations to paddy cultivation and also pay attention for buildup programmes to increase farmers' knowledge and make favorable conditions in the economy.

## APPENDIX



**Figure 8**  
**Picture name: paddy-field in Muthukandiya**  
**Source: field study[2016/09/23]**



**Figure 9**  
**Picture name: field by H8**  
**Source: field study[2016/09/23]**



**Figure 10**  
**Picture name :The cultivator is having a skin disease may be due to the excessive use of chemicals in paddy cultivation**  
**Source: field study[2016/09/23]**

**Figure 11**  
**Picture name: new veause**  
**Source: field study[2016/09/23]**



## REFERENCES

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# ASSESSMENT AND RECONSTRUCTION OF AAHPER TEST FOR SRI LANKAN YOUTH AGED 10 – 17

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**Abstract** - The physical fitness is the ability to carry out daily tasks with vigorous and alertness without undue fatigue. A fit and healthy person will live longer and Youth are backbone to nation. Therefore, the research question raised to assess the fitness level of the Sri Lankan youth and objective of the study was to construct a new fitness test norms for Sri Lankan age 11, 12, 13, 14, 15 and 16 years old youth boys and girls based on AAHPER test.

To achieve the purpose of this study 1000 girls and boys (age 10-17 years) selected from various provinces in Sri Lanka by random sampling method. The data were collected using the AAHPER test batteries which consist with six test items 50-yard run, standing broad jump, shuttle run, pull-up for boys and flex arm hang for girls, sit up and 600 yards run respectively and was analyzed by using SPSS. From the results, following percentile norms were created 5<sup>th</sup> 10<sup>th</sup> 15<sup>th</sup> 20<sup>th</sup> 25<sup>th</sup> 30<sup>th</sup> 35<sup>th</sup> 40<sup>th</sup> 45<sup>th</sup> 50<sup>th</sup> 55<sup>th</sup> 60<sup>th</sup> 65<sup>th</sup> 70<sup>th</sup> 75<sup>th</sup> 80<sup>th</sup> 85<sup>th</sup> 90<sup>th</sup> 95<sup>th</sup> 100<sup>th</sup>. From the results it was concluded that, newly constructed norms are slightly lower than AAHPER youth fitness test battery. Hence it was recommended that, newly constructed fitness norms are appropriate to categorize fitness level of the Sri Lankan youth. Further studies are essential to enhance the reliability and validity of the newly constructed norms.

**Key words** - Physical fitness, Youth age, AAHPER

## 1. INTRODUCTION

Physical fitness is defined as the ability of an individual to competently and capably perform everyday tasks without excessive fatigue, and with enough energy remaining to enjoy spending free

time, as well as to resolve unusual situations of sudden and unforeseen emergency. The expression “Physical Fitness” is used nowadays to describe a person’s ability to utilize the machinery of his body in sports and exercise. (COUNCIL1983)

Health and fitness are important for all individuals throughout life span. To achieve and maintain those qualities, an individual need to effectively handle disease and illness. Everybody desires a long and healthy life and exercise has a part to play in this. In one aspect, the body can be said to commence ageing from the moment it is born, However difference systems of the body age at a different rate. Many people continue a very active life both physically and mentally well up to their old age.

### A. Objective of the study

The objective of this study was to design a youth fitness test model for Sri Lankan youth aged 10 – 17, to assess the fitness level of Sri Lankan youth aged 10-17 and to study the feasibility of AAHPER youth fitness test in 10-17 years old. The research mainly based on “Assessment and reconstruction of AAHPER test for Sri Lankan youth aged 10 -17.

The researcher designs the research under the youth physical fitness of Sri Lanka. To measure the physical fitness of youth, use more standard tests in many countries. The AAHPER test is one of famous test for assess the youth physical fitness. As a Sri Lankan youth, still don’t have the standard test specific percentile norms’ value to measure the youth physical fitness. The revised AAHPER Youth Fitness Test is a battery of six test items designed to give a measure of physical fitness for both boys and girls

in grades 5-12. The tests were selected to evaluate specific aspects of physical status.

The tests are: pull-up (with flexed-arm hang for girls)for judging arm and shoulder girdle strength; flexed leg sit-up for judging efficiency of abdominal and hip flexor muscles; shuttle run for judging speed and change of direction; standing long jump for judging explosive muscle power of leg extensors; 50-yard dash for judging speed; and 600-yard run (with optional runs of 1 mile or 9 minutes for ages 10-12 or 1h miles or 12 minutes for age 13 and older) for judging endurance.(Hunsicker and Reiff, 1976)

When consider more about this, could assess and reconstruct the youth fitness test model based on AAHPER test. The age category is 10-17 years old based on AAHPER test.

## 2. METHODOLOGY

To achieve the purpose of this study 1000 girls and boys (age 10-17 years) selected from various provinces in Sri Lanka by random sampling method. Field based research design used for this research design.

The data were collected using the AAHPER test batteries which consist with six test items 50 yard run, standing broad jump, shuttle run, pull-up for boys and flex arm hang for girls, sit up and 600 yard run respectively and was analyzed by using SPSS.

## 3. RESULT AND DISSCUSSION

Below all tables indicates that the final outcome of the study 11 years old,12 years old,13 years old,14 years old,15 years old,16 years old girls and boys percentiles norms' value separately. These percentile norms' values were less than the AAHPER test percentile norms' values.

**Table 1.11 years old**

PERCENTILE	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
<b>BOYS</b>																				
50 YD S	9	8.8	8.8	8.7	8.6	8.5	8.5	8.4	8.4	8.4	8.3	8.2	8.1	8	7.9	7.9	7.6	7.5	7.4	7.1
SBJ	4	4.1	4.1	4.1	4.2	4.4	4.6	4.7	4.8	4.8	4.9	5	5	5	5.2	5.2	5.4	5.6	5.9	6
SR	12.2	11.7	11.6	11.4	11.2	11	11	11	10.9	10.8	10.8	10.7	10.7	10.6	10.6	10.5	10.4	10.2	10.2	10
PU	0	1	1	1	1	1	2	2	2	2	3	3	3	3	3	4	4	5	7	7
SU	16	18	20	20	21	23	25	28	30	30	30	30	31	32	32	34	35	35	36	38
600 YD R	3.8	3.1	3.06	3.02	3	2.99	2.8	2.61	2.56	2.5	2.4	2.36	2.31	2.26	2.26	2.25	2.25	2.21	2.19	2.15
<b>GIRLS</b>																				
50 YD R	9	8.8	8.8	8.7	8.6	8.5	8.5	8.4	8.4	8.4	8.3	8.2	8.1	8	7.9	7.9	7.6	7.5	7.4	7.1
SBJ	4	4.1	4.1	4.1	4.1	4.2	4.4	4.6	4.7	4.8	4.9	5	5	5	5.2	5.2	5.4	5.6	5.9	6
SR	12.2	11.2	11.6	11.4	11.2	11.1	11	11	10.9	10.8	10.8	10.8	10.8	10.6	10.6	10.5	10.4	10.2	10.2	10.2
FAH	0	1	1	1	1	1	2	2	2	2	3	3	3	3	3	4	4	5	7	7
SU	16	18	20	20	21	23	25	28	30	30	30	30	31	32	32	34	35	35	36	38
600 YD R	3.8	3.1	3	3	3	2.99	2.8	2.61	2.56	2.5	2.4	2.36	2.31	2.26	2.26	2.25	2.21	2.19	2.18	2.18

**Table 2.12 years old**

PERCENTILE	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
<b>BOYS</b>																				
50 YD S	8.3	8.8	8.6	8.6	8.6	8.4	8.2	8.2	8.2	8.1	8.1	8	7.9	7.8	7.6	7.5	7.4	7.3	7.2	6.5
SBJ	4.1	4.1	4.4	4.6	4.8	4.8	4.9	5	5	5	5.1	5.2	5.2	5.3	5.4	5.4	5.6	5.6	5.8	5.8
SR	12.8	11.5	11.4	11.2	11.1	11	11	10.9	10.8	10.6	10.5	10.4	10.3	10.2	10.1	10	9.9	9.3	9.2	9.2
PU	1	2	3	3	4	4	4	5	6	6	6	7	7	8	10	11	12	13	14	15
SU	15	20	20	23	25	26	26	27	28	29	30	30	30	31	31	32	34	34	35	40
500 YD R	3.12	3.09	3	3	2.91	2.28	2.28	2.26	2.24	2.24	2.19	2.18	2.16	2.15	2.14	2.12	2.11	2.1	2.1	2.5
<b>GIRLS</b>																				
50 YD R	11.3	9.6	9.5	9.4	9.2	9.1	9	8.9	8.8	8.7	8.6	8.5	8.3	8.3	8.1	7.9	7.6	7.5	7.3	7
SBJ	4.1	4.1	4.2	4.3	4.4	4.5	4.5	4.6	4.8	4.8	4.9	5	5	5.1	5.2	5.2	5.3	5.4	5.6	6.2
SR	13.3	12.7	12.6	12.4	12.2	11.8	11.8	11.6	11.6	11.5	11.5	11.5	11.4	11.4	11.2	11.1	11.1	10.9	10.7	10.5
FAH	5	6	7	8	8	9	9	9	10	10	10	11	11	12	12	12	12	13	14	15
SU	14	15	15	18	18	20	20	21	21	22	24	24	25	26	27	28	29	30	33	38
500 YD R	3.2	3	3	3	3	2.74	2.64	2.6	2.5	2.44	2.42	2.41	2.4	2.4	2.4	2.4	2.38	2.35	2.32	2.3

Table 3.13 years old

PERCENTILE	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
BOYS																				
50 YD S	8.5	8.3	8.2	8.2	8	8	7.9	7.9	7.8	7.7	7.6	7.5	7.4	7.3	7.2	7.2	7	6.7	6.2	6.2
SBJ	4.1	4.8	5	5.1	5.1	5.1	5.1	5.1	5.2	5.4	5.4	5.5	5.6	5.6	5.8	5.8	5.8	5.9	6	6.2
SR	12	11.9	11.5	11.4	11.1	11	10.9	10.8	10.6	10.6	10.5	10.4	10.4	10.3	10.2	10.2	10.1	9.8	9.6	9.5
PU	2	3	3	4	4	4	5	5	5	5	6	6	6	6	7	7	7	8	9	10
SU	26	28	28	30	31	31	32	32	34	34	34	35	35	36	36	37	38	38	40	40
600 YD R	2.6	2.31	2.21	2.2	2.18	2.16	2.15	2.13	2.1	2.1	2.08	2.08	2.07	2.06	2	2	2.05	2.05	2.04	2.04
GIRLS																				
50 YD R	11	9.7	9.3	9.1	9	9	8.8	8.7	8.7	8.6	8.5	8.5	8.4	8.4	8.2	8.1	7.9	7.7	7.4	7.4
SBJ	4	4.1	4.1	4.2	4.4	4.5	4.6	4.7	4.8	4.9	5	5	5.1	5.2	5.2	5.2	5.4	5.6	5.8	6
SR	13	13	12.7	12.4	12.1	11.9	11.9	11.6	11.5	11.5	11.4	11.3	11.2	11.2	11	10.9	10.8	10.6	10.5	10.2
FAH	4	5	6	6	6	7	8	8	8	8	9	9	10	11	11	11	11	12	12	13
SU	18	22	23	24	25	26	26	26	27	28	28	29	30	30	30	31	32	33	34	40
600 YD R	3.5	3.01	3	2.82	2.6	2.52	2.5	2.46	2.42	2.4	2.4	2.38	2.38	2.34	2.31	2.3	2.3	2.3	2.28	2.28

Table 4.14 Years old

PERCENTILE	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
BOYS																				
50 YD S	9	8.6	8.5	8.4	8.2	8.2	8.1	7.9	7.9	7.9	7.8	7.8	7.7	7.7	7.6	7.5	7.3	7.1	7	7
SBJ	4	5	5.1	5.1	5.1	5.2	5.4	5.5	5.7	5.8	5.9	6	6	6.1	6.1	6.2	6.4	6.5	6.7	6.9
SR	12.2	11	10.5	10.5	10.4	10.3	10.2	10.2	10.1	10.1	10	9.9	9.8	9.7	9.7	9.6	9.6	9.6	9.3	9.3
PU	0	3	4	4	5	5	5	5	5	6	6	6	6	7	7	7	8	8	9	9
SU	16	30	32	32	34	34	34	35	35	36	36	38	38	38	39	39	40	40	41	43
600 YD R	3.8	2.26	2.18	2.18	2.16	2.13	2.12	2.11	2.1	2.1	2.1	2.08	2.06	2.05	2.05	2.03	2	2	1.59	1.59
GIRLS																				
50 YD R	9.9	9.5	9.4	9.2	9.1	9	8.9	8.9	8.8	8.8	8.7	8.6	8.5	8.5	8.4	8.2	8.2	8.1	7.6	7.4
SBJ	3.9	4	4.1	4.2	4.5	4.6	4.8	5	5	5.1	5.1	5.1	5.1	5.4	5.5	5.6	5.8	5.8	5.8	6
SR	14.2	13.8	12.5	12.4	11.9	11.8	11.7	11.6	11.5	11.5	11.3	11.2	11.1	10.9	10.9	10.8	10.7	10.5	10.2	10
FAH	4	5	6	6	7	7	8	8	9	9	10	10	10	10	11	11	11	12	12	12
SU	21	23	24	26	26	26	28	28	28	29	30	30	30	30	31	32	32	34	35	38
600 YD R	3.11	3.02	3	2.95	2.59	2.42	2.41	2.4	2.4	2.4	2.38	2.36	2.36	2.33	2.32	2.31	2.3	2.3	2.28	2.24

Table 5.15 years old

PERCENTILE	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
BOYS																				
50 YD S	8.3	8.1	7.8	7.5	7.4	7.3	7.2	7.2	7.1	7	7	6.9	6.9	6.8	6.8	6.7	6.6	6.5	6.2	6.2
SBJ	5.1	5.5	5.7	6	6.1	6.1	6.1	6.5	6.5	6.8	6.8	7	7	7	7.1	7.1	7.2	7.2	7.6	7.8
SR	11.2	10.5	10.5	10.4	10.4	10.3	10.2	10.2	10.1	10	9.9	9.9	9.6	9.5	9.5	9.4	9.3	9.2	9.1	9.1
PU	5	5	5	6	6	6	6	7	7	7	7	7	7	8	8	8	8	9	9	9
SU	29	30	30	30	31	32	33	34	34	35	35	36	36	37	38	38	40	41	41	46
600 YD R	2.59	2.23	2.14	2.1	2.07	2.01	2	1.73	1.59	1.58	1.56	1.56	1.51	1.5	1.5	1.49	1.46	1.41	1.4	1.4
GIRLS																				
50 YD R	9.2	8.8	8.6	8.5	8.4	8.4	8.2	8.2	8.1	8	7.9	7.9	7.8	7.7	7.7	7.6	7.5	7.2	7	6.2
SBJ	4.2	4.8	4.9	5	5	5.1	5.1	5.1	5.2	5.2	5.3	5.4	5.5	5.6	5.6	5.7	5.8	5.8	5.8	6
SR	12.5	11.8	11.7	11.7	11.6	11.6	11.6	11.4	11.2	11.2	11.1	11	10.9	10.9	10.7	10.6	10.5	10.4	10.3	10.1
FAH	0	0	4	5	5	6	6	6	7	7	7	8	9	9	10	10	11	11	11	12
SU	28	28	28	29	29	29	30	30	30	30	30	31	31	32	32	33	34	34	35	38
600 YD R	3	2.41	2.4	2.4	2.4	2.37	2.36	2.35	2.35	2.34	2.34	2.32	2.31	2.3	2.29	2.28	2.28	2.26	2.25	2.25

Table 6.16 years old

PERCENTILE	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
BOYS																				
50 YD S	9.8	8.9	8.7	8.6	8.6	8.5	8.4	8.3	8.1	8.1	6.8	6.7	6.6	6.5	6.4	6.4	6.3	6.2	6.1	6
SBJ	5.2	5.4	5.5	5.6	5.7	5.8	5.8	5.8	5.9	6	6	6.1	6.1	6.1	6.1	6.1	6.5	6.5	6.6	6.6
SR	11.9	11.5	11.4	11.4	11.4	11.2	11.1	11	10.9	10.9	9.6	9.5	9.5	9.3	9.2	9.2	9.2	9.1	9.1	9
PU	7	7	7	7	8	8	8	8	8	8	8	9	9	9	10	10	10	10	10	11
SU	32	33	34	36	36	36	36	38	30	30	32	32	32	33	34	34	34	35	35	38
600 YD R	2.9	2.67	2.58	2.51	2.45	2.41	2.36	2.32	2.32	2.31	2.3	2.3	2.3	2.3	2.3	2.29	2.29	2.26	2.25	2.25
GIRLS																				
50 YD R	9.8	9	8.9	8.7	8.6	8.6	8.5	8.4	8.3	8.1	8.1	8	7.9	7.9	7.8	7.8	7.7	7.5	7.2	7.2
SBJ	4.1	4.1	5	5.1	5.1	5.1	5.1	5.1	5.2	5.2	5.4	5.5	5.6	5.7	5.8	5.8	5.8	5.9	6	6.2
SR	11.9	11.5	11.4	11.4	11.2	11.2	11.1	11	10.9	10.9	10.8	10.8	10.7	10.6	10.5	10.3	10.2	10.1	10.1	10.1
FAH	2	3	5	6	6	7	7	8	8	8	8	9	9	9	10	10	10	10	10	11
SU	26	26	27	28	28	29	30	30	30	30	32	32	32	33	34	34	34	35	36	38
600 YD R	2.9	2.67	2.58	2.51	2.4	2.41	2.36	2.32	2.32	2.31	2.3	2.3	2.29	2.29	2.26	2.25	2.25	2.24	2.05	2.03

## 5. CONCLUSION

This study was assessment and reconstruct of AAHPER test in Sri Lankan youth aged 10-17(n=1000). The test battery consist with six test items give a measure of physical fitness for both girls and boys also provide keen incentive to improve fitness level of youth .According to data analysis, there is anorms' value of relevant percentiles to measure the youth physical fitness in Sri Lanka.

The analysis norms' value of both girls and boys indicated a significant difference in comparison with the AAHPER test standard norms' value.

The statistically comparison of all test scores both girls and boys were actually decreases performance in 100th percentile norms' value. The reconstruction of AAHPER test in Sri Lanka represent an important innovation in the field of physical education and youth fitness it is dedicated to providing the best possible physical fitness assessment.

## 6. RECOMMENDATION

According to this research government should take process to assess the physical fitness level of youth aged 10-17 and conduct the physical fitness programmes. Ministry of Sports and Ministry of Education should consider the reconstruct percentile norms' values and when assess the fitness level use this relevant age and relevant test items percentile norms' value.

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*Law*

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“Law and justice in the global environment:  
Challenges and Responses”

## SESSION SUMMARY

### Plenary Session Summary

The plenary session, themed “Law and Justice in the Global Environment: Challenges and Responses” was chaired by Prof. Camena Gunaratne, Dean, Faculty of Humanities and Social Sciences of the Open University of Sri Lanka and the session was consisted of five speeches lined up under five different topics. The first speaker Mr. Palitha Fernando PC, a Former Attorney General in Sri Lanka addressed the gathering on the topic “Law and Justice on the Global Environment; Challenges and Responses”. The second speech was delivered by Ms Wasantha Seneviratne, a senior lecturer and current Acting Dean of the Faculty of Law, University of Colombo on the topic “Administration of Justice with Special Reference to Human Rights Protection: Challenges and Prospects”. The third speaker Prof Alfred Soons, chairperson for the

Scientific Advisory Council of the Netherlands Defence Academy and member of the advisory body of experts on the Law of the Sea of the International Oceanographic Commission enlightened the participants on the topic “Climate Change and Ocean Governance: Consequences of Sea-Level Change”. The fourth speaker, Associate Prof. Leanne Wiseman, Associate Director of ACIPA and Associate Professor in Law at Griffith University explained the new dimensions of the intellectual property law speaking on the topic “Opening Access to Research and Data: Empowering Research Communities”. The fifth and final speaker Dr. Kalana Senaratne delivered his speech on “International Law and Justice; Some Preliminary Thoughts on a Strained Relationship”. Each of the presentations was followed by a question and answer session which provided an opportunity for the participants to get interacted with the speakers.

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*Plenary  
Speeches*

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# LAW AND JUSTICE IN THE GLOBAL ENVIRONMENT; CHALLENGES AND RESPONSES

Rear Admiral (Retd) Mr. Palitha Fernando,  
PC

**Abstract** - The rapid expansion of the scope of International law in the past few decades has had a significant impact on States. Law and justice stands prominently in this respect. Adoption of international standards within domestic jurisdictions and scrutiny of law enforcements within domestic jurisdictions by the international community has remarkably grown. This has restricted the traditional concept of Sovereignty. The international community has identified areas of international concern and has taken giant strides in promoting protective measures through law enforcement. Some of the areas that have come within this scope are Human Rights, Humanitarian Law, Restriction of destructive armament, and Global environment.

Accountability of individuals and the right of individuals to enforce claims against State entities are been considerably developed. Domestic legal structures and enforcement need to be restructured and revised to meet international standards and international scrutiny.

This paper would consider challenges faced by States in the Global environment in light of the above aspects

**Transcribed plenary speech of Rear Admiral (Retd) Mr. Palitha Fernando, PC**

With the new millennium and with the changing world, law and justice have several challenges to meet. As you know, the difference between the domestic area and the international territory is fast diminishing. What we considered to be a sovereign state with all powers is now diminishing because there is a lot of international focus on the domestic affairs of any state.

What I wish to say is that I feel in the years to come, this is going to expand further and the domestic arena is going to constantly be under the supervision and focus of the international community. I believe it is a welcome move because with the expansion of international law which was once considered to be a system which deals with states is

expanding its area and scope fast. Because of that today the individuals, national organizations and most other areas have come within the scope and focus of international law.

We also know of Monism and Dualism. We speak of dualist states and our own state is one of them, where we do not consider international conventions as our own law, unless it is absorbed into our legal system by legislation. But we see a shift from the dualist approach in the commonwealth countries, which follow the common law system. Sri Lanka was itself a colony of the British, as a result of which we too inherited the dualistic system but today we see that we too are moving slightly toward the monist system, where we consider international law with more generosity, and consider international conventions and think that international conventions should be applicable in the legal system of our country even though we have not totally divorced ourselves from the dualist system.

So in a situation like this, the challenges we are going to face in the future are tremendous. When I looked at the topics to be covered by some of the lecturers today, I see we will be dealing with human rights. Human right is an area where international focus is expanding very fast. As a result of that human rights has become one of the most important topics ever discussed, and also topics which concern the international community in a big way. Today we cannot think of any form of international dealings without human rights coming forward. With the 20th century what happened was there were institutions which dealt with international law and those helped find those responsible for violations in those areas. Whenever an individual was to be treated for a violation of international humanitarian law, or a violation of human rights it was always done by a tribunal like the Nuremberg trials and the Tokyo tribunals. But now we see with the creation of the international criminal court by the Rome statute there's a permanent international criminal court imposing criminal liability on individuals in the area of human

rights. I think this is a step that we have taken forward but unfortunately Sri Lanka has not ratified the Rome statute yet. Though Sri Lanka has not ratified this statute, we are aware of the international repercussions as far as human rights violations are concerned where the international criminal court has jurisdiction to try persons who cannot be tried by the domestic system.

This I think is a move in the correct direction because human rights are considered to be important. Immediately after WWII, when the leaders got together to decide as to what steps they should take to prevent a WWIII and found that HR violations were the root cause for both WWI and WWII. That was the commencement of the UDHR. Commencing from the UDHR, up to the international criminal court created by the Rome statute, I think we have come a big way, and that is going to be one of the greatest challenges in the years to come. Wherever HR violations take place or wherever HR violations are highlighted the international community is going to take the steps that they are able to take in terms of the new provisions including the Rome statute where the international criminal court was created.

What I believe is one of the greatest challenges we have to face in the new millennium, one of the greatest challenges in global law and justice and protection of HR, guaranteeing of HR to the citizens of your whole country. This is one aspect that will be highlighted and I see that there is a speaker for this particular topic and I'm sure she will deal with this in greater detail

Two aspects that I see as areas where there will be a lot of development and responses are the global environment where there is a duty by the international community and the members of all domestic states to take all possible steps to protect the global environment. I will refer to you an advisory opinion given by the international court of justice. This was about the use of nuclear power. The dissenting decision by one of the SL judges, justice Weeramantry where he said that the use of nuclear power would be illegal in terms of international law. The basis upon which he expressed this opinion was that the use of nuclear power would have a devastating effect on the environment, and that cannot be done because we have a duty towards the future generations and also towards the members of the international community. This was dissenting, so the majority judgement did not follow this judgement, but in this minority judgement he has highlighted a fact that it is absolutely necessary that we be mindful of the impact nuclear weapons would cause on the environment. So, I

thought I would highlight to you in my speech because this again is going to be one of the greatest challenges that we have to meet in the years to come, where as you know these days a lot of discussion is taking place about the nuclear tests that have been conducted by some countries and whether they are in violation of the international conventions by which they are bound. So this area is going to be one of the greatest challenges that we have to meet since the use of nuclear weapons is going to be a potential threat in the years to come and pose potential danger to all mankind. As a result of that it is necessary that we look at this matter in this new millennium when we speak of global justice in order to prevent any activities taking place in those areas.

Another aspect that would be extremely important when we speak of the global environment and the law and justice in the global environment other than the protection of HR, and the guarantee of HR to all, I think, is where development comes in.

Wherever there is development, there is caused some sort of damage to the environment. There is a judgement of the international court of justice in *Hungary V Slovakia*, a case in which the judges of the international court of justice discussed the importance of development. Devoid of development we cannot think of moving forward, and development is extremely necessary. But in that particular judgement 2 important concepts were highlighted and those 2 concepts have entered into the judicial systems of members of the international community including SL.

The first is sustainable development. Sustainable development is something that we ought to take care of because unless there is sustainable development, development is indeed of no use. In this judgement, specific attention has been paid to development and also how much its impact upon the world's resources would be. It was a long time ago that Mahatma Ghandi when he was questioned on something he said, said "the resources of the world would be sufficient to satisfy the needs of the people, but not the greed of the people". That exactly is what is highlighted in this judgement where they say sustainable development, the process of development, should be formulated by legal principles. The law should step in wherever they find that development is going to cause a problem in the resources of the world. This was a case where there was a dam erected and the damage it was going to cause was immense and the international court of justice proceeded on the basis that there is no provision to object to the development where it causes some sort of

damage to minimise the damage as much as possible to regulate such activities by legal provisions. So sustainable development is going to be a world concept in the near future. It is gained ground already and is going to be emerging as a concept that is absolutely necessary in the areas of development.

The other area that I wish to concentrate upon is a new area which has also been highlighted in some judgements of the international court of justice, now intergenerational justice. Intergenerational justice is that we ought to consume our resources keeping the future generations in mind. We are the custodians the world today and when it comes to the world tomorrow, we ought to remember that there is a generation unborn who would be entitled to depend upon those resources.

The very important concept of intergenerational justice that is highlighted and has been pointed out that this intergenerational justice is accepted. What it means is that what would be of the future generation supposing we did not have them in mind in the world development

effort in today's world. International law comes in all these areas. It is devoid from domestic law, as you all are aware. When it comes to international law where we come into dualism and we accept monism as one of the areas where international law must be accepted by the global community. In that attempt I'm sure that the impact on HR, on the natural resources of the world and the protection of the global environment are going to be of utmost importance and when we speak of today's topic; challenges and responses of the global environment, we are not the domestic environment because whenever we take steps in the domestic environment it is absolutely necessary that we keep in mind that whatever we do will have an impact on the global environment also. So, as I stated at the commencement of my presentation, the concept of absolute sovereignty is fast diminishing. The concept of dualism is fast diminishing and today we are gradually going towards an international environment within which there should be a place regulated by international law in which a safer world would be created, not only for the generation living, but also to the future generations to come.

# ADMINISTRATION OF JUSTICE WITH SPECIAL REFERENCE TO HUMAN RIGHTS PROTECTION: CHALLENGES AND PROSPECTS

**Ms W Seneviratne**

Head, Senior Lecturer, Department of Public and International Law,  
Faculty of Law, University of Colombo, Sri Lanka

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**Abstract** - In the process of administration of justice, victims of human rights violation cases are not always remedied as per the international standards. As a result, access to justice is not always guaranteed for those who look forward for justice. This might create a gap between the established law and ensuring justice. This is apparent in particular in the area of human rights protection. Despite the progressive developments ensue in international human rights treaty law due to the lethargy of the legislatures in states which follow dualistic approach in incorporating international law into domestic law people in such countries whose human rights are violated by the state instruments are unable to profit from those progressions occur at the global level. In exceptional occasions Sri Lankan judiciary has attempted to address this injustice through judicial activism.

They have not departed from the traditional dualistic tradition but have done the justice to victims of human rights violations through different judicial interpretations and also by way of creeping through monism. In monist countries when international treaties are ratified or acceded by states, those international treaties become self-executing. Hence, the judges can adjudicate the cases in light of the legal principles stipulated in such treaties without the need of transformation of them to domestic law through acts of legislature. Nevertheless, one may argue that through this approach the executive branch of the government would have more powers in the process of international incorporation of treaties and the judiciary can bypass the legislature and directly apply the principles of international treaties to the cases before the courts. In contrast, in dualistic countries treaties will not automatically become executed but those should be incorporated through an enabling statute adopted by the legislature. Thereby the legislature maintains the monopoly

of law making authority without leaving any space for the judiciary to do so. However, many states traditionally known to be dualistic countries now dramatically use the legal principles embedded in treaties which are transformed to be customary international law principles to be invoked without the need of an enabling legislation. This trend could be seen through the jurisprudence of many apex courts of India, Canada and Australia in spite of the fact that those states maintain the dualistic tradition of international incorporation.

However, Sri Lankan judges have faced with a blockade in *Nallaratnam Singarasa v. Attorney General* judgment and as a result, the emerging monist trend created by previous judges through landmark judgments seems to have been ended. Therefore, it is important to examine the way forward for Sri Lanka in the post Singarasa era in order to overcome such negative implications that hinder the access to justice through the monist passage for the victims of human rights violations. This research paper thus wishes to examine such new trends emerging in many such jurisdictions and some of the positive and negative examples drawn from Sri Lanka. Therefore, the research question addressed in this research is Can Sri Lanka's judiciary, though not empowered to make legislations, interpret Sri Lanka's obligations under international law into the municipal law of the country in pronouncing its decision in a case concerning issues of international law? The methodology used in the research is qualitative and many text books, scholarly articles and case law jurisprudence of a number of jurisdictions have been used.

**Key words** - Administration of Justice, human rights protection, monism, dualism



### Transcribed plenary speech of Ms Wasantha Seneviratne

I have selected the topic of “Administration of Justice with special Reference to Human Rights Protection: Challenges and Prospects”. In fact, I am very thankful to Honourable Former Attorney General Palitha Fernando for paving way with references to cooperation of International Law and emerging trends with regards to creeping towards monism which would be the clasp of my presentation as well, with some highlights on judicial activism and some selected jurisdictions.

We find international law to be very important and it includes Treaty Law and Customary International Law as predominant sources of law. But at the same time International Law does not direct towards the obligatory States as to which way should be used when incorporating international law in their domestic systems. As a result, we find number of diverse practices as well as patterns emerged in the different jurisdictions and under this some countries prefer monist tradition of international law reception and in other countries they prefer the dualistic tradition of international law incorporation.

I wish not to embark on the differences between monist school of law and dualist school of law, but I wish to show that either by monism or dualism the expected ambit is the flourishing trends of the global level to be transferred to the domestic level, and eventually for the benefit to be given to the people. Unfortunately, we find that the reality in the ground level, especially in cases of violations of human rights the victims do not gain the benefit of these emerging trends of the global level due to many reasons. Perhaps this could be due to the lethargy of the executive branch or the legislative branch of the state organs. Therefore, I thought that I should specifically focus on the question, “whether the judiciary can eliminate the lethargy of the above-mentioned branches by judicial activism and whether such method could provide justice to the people in the country”.

When we look at the monistic school of law and the dualistic school of law, we find in monist countries without the deed of an emerging legislations, treaties that have been ratified by the states can be incorporated to the domestic laws, and these treaties could be named as “Self-executing treaties”. Nevertheless, most countries are under the recognition of being dualist countries and they require an expressive act by the legislator, in the name of an enabling legislation and without which in most of those countries judiciary are reluctant to incorporate those international standards to which their domestic states

become a party, which highlights the need for an enabling legislation.

With the emerging new trends in the world, it is important to discuss “whether the Sri Lankan judiciary is free to interpret Sri Lankan obligation to under international law into its municipal law backdrop in announcing a case concerning issues of international law without an enabling statute”. In certain human rights cases, in fact some of the Sri Lankan judges have felt that they should administer justice through judicial activism although they are not to depart from the traditional dualistic tradition. However, they have administered justice to human rights violations through different interpretation and by creeping through monism. Thus, few minutes should be used to explain the modern trend of creeping towards monism in the world, and as to how we can move away from the positivistic school of thought.

I will first take an example from the United Kingdom with the corporation of treaty law and customary international law by citing several known cases. In *Trendtex Trading Cooperation v Central Bank of Nigeria*, Lord Denning states, “seeing that the rules of International Law have changed and do continue to change, and also courts have given place to the changes without an act of parliament it follows to my mind inevitable that the rules of international law as existing from time to time do form part of our English Law... We should give effect to those changes and not be bound by the stare decisis of the international law”. In the given case, Lord Denning's exact words show us that the domestic courts have responded to important changes in the international law by moving away from dualism to monism, to accommodate these changes. Nevertheless, it was not uniform.

However, while treaties required to be transformed into law by legislation, a customary principle is automatically incorporated into English law. It is an important area that should be followed by Sri Lankan judges, meaning, even if the principles of stipulated treaties cannot be incorporated into law due to dualistic tradition, the customary international law principles embedded into the treaty law can sometimes be adopted by the judges by moving away from the dualistic nature. If we take one of the most important human rights treaties out of the ICCPR and ICESCR, the twin treaties of 1966 are considered to be consisting of Customary International law. As a result, most of the later Human rights conventions largely spell out principles that are found on the afore mentioned human rights treaties. Many treaty law principles stipulated in Human Rights Conventions have now as a

result become customary international law principles and it is the same with regard to International Humanitarian law which are also found in the Geneva Conventions, Hague Conventions and Regulations.

Now if we look at the proposed change, judges may creep through the dualist system and away from it toward monism, therefore there could be some objections. One argument is that this is an undemocratic law making by the courts, counter arguments could be that the States through their state practices and opinion juris undertake such customary international law. Therefore, these customary international laws may be binding on such states, which may not even be against the sovereignty of the Country. If the executive opposes to this kind of judicial activism, it can undo a judgment. In the Australian judgment of *Teoh v Minister of Immigration*, 1995, the Australian High court used the CRC (Convention on the rights on Children) to invalidate a deportation order against Teoh made by the judge on the basis of Teoh's conviction. The judgment of the Australian case has above has been subjected to much criticism and as a result, the decision of the High Court was overturned by the legislation.

If I am to take another example, which is from India, the Indian Courts have come to the view that it should be the executive who views the treaty. The executive should ensure that the treaty becomes law in the state. Where there is undue delay by the legislative and executive branches in passing the legislation, in transforming the treaty into domestic law, judiciary can take the view provided in order to protect the rights of people. Taking the Indian case of *Vishaka v State of Rajasthan*, 1977, the judgment was unprecedented for several reasons. The Supreme Court acknowledged and relied to a great extent on International Treaties that had not been transferred into municipal law. The Supreme Court provided the first authoritative decision of sexual harassment in India and confronted the Statutory vacuum, it went creative and proposed a root of judicial legislation. Therefore, I think there could be a brighter future that we can forecast even from the Sri Lankan cases. Thus, one of the recent Supreme Court judgments in Sri Lanka is brought up in here. *Manohari v Secretary of Ministry of Education*, 2016, where in relation to Fundamental Rights, sexual harassment experienced by a female teacher was determined as a violation of her right to equality and non-discrimination which invoked the Convention on the Elimination of all forms of Discrimination against Women.

Declaration contained in the Bangalore Principles on the Domestic Application of Human Rights Norms,

1988, were the result of a meeting of leading lawyers of common law world and this Declaration provides that, "it is within the proper nature of the judicial process and well established judicial functions for national courts to have regard the international obligation which a country undertakes whether or not they have been incorporated into domestic law, for the purpose of removing ambiguities or uncertainties from national constitution, legislation or common law". However, the Bangalore Principles have held that it is important for the judges of dualistic nations to be free from any rigid form of dualism developed by the English Common law. The crucial idea of the above principles was that International Human Rights Law might sometimes provide guidance to judges in cases concerning human rights and fundamental rights, where their domestic law is silent. Michael Kirby J of Australia states that, "after observing Bangalore Principles he had found some cases that came before him in his courts, and he began to see the way in which reference to International Law can be done when the domestic law seems to be silent".

I will now try touch on Sri Lanka and on its role of dualism, which has been diminished in the modern world but is still in occurrence in Sri Lanka. The Sri Lankan judicial activism of international law incorporation shows diverse ends as we are not very reformed. With regard to Treaty Law incorporation, Sri Lanka follows dualistic school of law as similar to many other Commonwealth countries, but in certain cases we proved to be more dualistic and very rarely have we shown our inclination towards monism. In cases like *Tikiri Bandara Bulankulama v The Minister of Industrial Development (Eppawala Case)*, judgment used a concept which is only found in international environmental law which was the notion of equity. This Principle has been highlighted by Weeramantry J in the case concerning *Hungary v Slovakia* having made reference to the contents of Sri Lankan philosophy and our legacy. In his judgment *Amarasinghe J* stated that, "either expressly enacted or by becoming part of the domestic law by the adoption by a superior court of record and by the Supreme Court in particular in their decisions, Sri Lankan judges can refer to International law in the absence of enabling legislation in Sri Lanka" showing that we have crept through monism in this particular judgment. Nevertheless, it is not so in every case and that we sometimes find that the trend has been reversed although the *Bulankulama* case was supportive of monism. In the controversial case of *Nallarathnam Singharasa v Attorney General*, decided by the Supreme Court it could be seen that the same positive reaction towards monism was not adopted in all cases of

judicial activism in Sri Lanka. In this case it was expected that the International Covenant on Civil and Political Rights should be embarked on our country by having a way of enabling legislation.

In conclusion, it could be stated that, in Sri Lanka in some cases judges have become very positive and they have used judicial activism in order to creep towards monism while

some did not and has been travelling reversely towards rigid dualistic system. Finally, I would like to touch on who would be benefitted, and the benefit should be given to the victims of those cases of violations of rights. As final analysis, what we should do is, as human rights have been tailored to protect the people and not the State, People should be protected by law as the rights of the people are paramount.

# CLIMATE CHANGE AND OCEAN GOVERNANCE: CONSEQUENCES OF SEA-LEVEL CHANGE

**Prof A Soons**

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**Abstract** - One of the most important consequences of climate change is the rising sea-level. Sea-level has been rising for several decades, and during the current century is expected to rise further: estimates vary between almost one meter to much more, depending in particular on the speed of the melting of the Antarctic ice caps. So there is great uncertainty about the extent of this rise. At the same time, sea-level rise constitutes one of the 'changing dynamics in the global environment', and raises great challenges for law and justice in this global environment.

The rising sea-level will not only affect the geographical extent of land areas: low-lying coastal areas will become inundated or uninhabitable. For some coastal States, with vast low-lying coastal areas with a small gradient, this will have significant consequences. Large coastal populations will eventually have to move, unless timely protective measures have been taken. Often this will not be possible. In particular low-lying island States must even fear for their own physical survival.

But part from this loss of land, sea-level rise will also have another consequence for these low-lying countries, especially those constituted by islands: loss of sea areas over which they exercise sovereignty or jurisdiction. The sea areas subject to coastal State jurisdiction can be enormous and sometimes are of great importance economically for these States. In addition to the territorial sea of 12 nautical miles, the exclusive economic zone (EEZ) extends to 200 nautical miles (370 km) from the so-called 'baseline' (usually the low-water line along the coast), and the continental shelf can even extend much farther from this baseline. If the baseline recedes as a result of sea-level rise, the outer limits of the EEZ or continental shelf would recede accordingly. Should an island (and thus the baseline) disappear entirely, the EEZ around such island may also be lost.

This presentation will examine the consequences of sea-level rise for the extent of maritime jurisdictional zones

to which coastal States are entitled under international law. In particular the presentation will identify possible ways for the affected coastal States to take timely measures to prevent or mitigate this imminent loss of maritime jurisdictional zones. These measures could be unilateral, regional or at a global level. They imply the invocation of justice in the global environment.

## **Transcribed plenary speech of Professor Alfred Soons**

Under the topics that I would like to discuss with you, after a brief introduction on the Rising Sea Levels, I would like to focus on the loss of Maritime Jurisdiction Zones as a result of shifting baselines and I will pay less attention on the Loss of Land due to rise of Sea Levels. Then I would like to touch on the topic which is related to the theme of the law session which is Law and Justice in the Global Environment and then I will move on to potential adaptations measures to come to the effects of the rising sea level and I will end with few concluding remarks.

When talking about climate change in relation to international law, it is always important to know the facts and the causes that affect the climate change. The cause of global warming is of course the emission of greenhouse gases and we need measures for prevention and mitigation. The whole field of mitigation and prevention of global warming falls under the field of International Environmental Law. Then we move on to speak on the effects of measures for mitigation and adaptation. Again, going back to the causes, the warming of the atmosphere through the greenhouse gases lead to the warming of the ocean which also acts as a reservoir of greenhouse gases resulting acidification of the ocean. This ocean warming and acidification leads to a series of causes or effects such as melting of sea ice especially in the North in the Arctic Ocean, rising of sea level where the predictions given for this year is below 1m but now the predictions are on the verge of increasing above 1m or even more as there is a considerable rise on sea water levels. There are other

effects such as the, changing of ocean circulation patterns, impacts on marine organisms and the effects on the fish stock of the ocean. All these changes have international legal consequences.

Concentrating on the effects of sea level rise on maritime limits and boundaries, in particular on Low Lying States (islands) which are very vulnerable as they are states with low coasts, and here in the Indian Ocean the primary example of Low Lying States would be the Maldives and the main potential victim are the South Pacific Island States like Tuvalu, Federated States of Micronesia, Marshall Islands and few others which consist entirely of Low Lying Islands. Obviously when sea level rises, you lose land and the ocean advances as a result of sea level rise which results a series of questions for the residents of such islands. Questions such as emigration, evacuation or resettlement of the civilians of such states and if no population is left, what happens to the state arise due to the consequences of rise of sea levels. Nevertheless, the focus in this presentation would be on loss of sea area, or maritime area. The sea areas are very important for island states, sometimes even economically important than their land area due to availability of resources and fisheries and also for security.

Therefore, it is important to briefly understand the maritime zones; territorial sea of all coastal states of 12 nautical miles, exclusive economic zone of 24 nautical miles, continental shelf which can extend beyond 200 nautical miles, and all these are controlled by the United Nations Convention on Law of the Sea (UNCLOS) to which Sri Lanka is a party and also played an important role in drafting the convention. All these distances are measured from the baseline which is the low water level of the coast which will obviously shift when the sea water level is rising thus, baselines shift inwards which results shifting of the outer limits of the maritime areas correspondingly. In some cases, this inwards shift is only a few meters if the coast is steep, but in coasts of states such as the Bangladesh where the coast only rises to about one metre means that shifting of baseline could mean loss of land in several kilometres to the sea. Effects on the gradient of the coastal area where you have low tide elevations has a significant impact on measuring the breadth of such states' maritime zones. As an example, in the Kingdom of Netherlands, in the Caribbean the Little Curaçao where if the sea level rises half a metre the whole island would disappear. Such other examples are Sipadan of the Coast of Borneo, Isla de Aves of the Caribbean, Venezuela and if the latter island disappear the state of Venezuela would lose thousands

of kilometres of sea area as it would no longer generate maritime zones.

Special issue concerned is that of such islands becoming a rock as provided by the Article 121 (3) of UNCLOS which means it can no longer generate 200-nautical mile exclusive economic zone and can only obtain the 12-nautical mile territorial sea. An example of such an instance would be the Okin-tori-shima which is also known as the Bird Island, 600 miles to the south of Japan where Japan has claimed 200 nautical miles for the "rock" by conservation of it at the expense of millions of dollars

Thereby, there must be potential adaptation measures which can provide solution to the effects of rise of sea level. The first measure would be to conclude delimitation agreements among states adjacent to one another. Secondly, we could move to the artificial conservation of the natural baseline by building artificial sea walls, which is expensive and often impracticable, yet it has been followed by Japan regarding Okino-tori-shimo which may not be suitable in every circumstance. Moving on to legal measures that could be taken, states could unilaterally claim "historical waters" which is done by Sri Lanka regarding its oceanic area in the north. A better way for a solution would be to develop new rules of International Law which provide an entitlement to coastal states to keep pre-existing outer limits of offshore areas by an amendment to the UNCLOS, or by a separate treaty, or by a rule of customary international law. The reason behind such new rule should be different from the current rules governing the coastlines, and it should be providing justice to the victims of global warming and sea level rise.

As an effect of the adaptation of potential methods mentioned above, island of Male in the Maldives, is now in fact becoming completely an artificial island and it shows the effect of the engineering measures taken up by a state. Tuvalu in the South Pacific which consists of a series of islands, if a physical defence is to be built to protect the islands, it would be completely unrealistic. In the main island Funafuti to protect two and a half square kilometres of land 54km sea defence would be necessary which shows sea defence is not always cost effective.

As conclusion, even though I have dealt with only one issue of climate change and sea level rise, there are many issues of climate change and moreover, many consequences of climate change are unclear. But to provide solutions for such issues, creative or innovative approaches are required.

# OPENING ACCESS TO RESEARCH AND DATA: EMPOWERING RESEARCH COMMUNITIES

**Associate Prof L Wiseman**  
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**Abstract** - The shift to Open Access (OA) for research began almost 25 years ago with various public statements on the importance of making research freely available. These included the Budapest Open Access Initiative, the Bethesda Statement on Open Access Publishing, and the Berlin Declaration on Open Access. With idealistic motives, great enthusiasm and, in some cases, pressure from a wide range of stakeholders including private and public research funders, OA was justified on the basis that the full social and economic benefits of research should be available to everyone who could use and build on the research to improve society and people's lives. More recently, OA principles and policies have extended to not only to the research being done, but also to the data underlying the research.

The opening of access to research and data has posed its own challenges. But as most of the international policies and statements highlight, it is the laws of privacy and intellectual property that can potentially hinder or obstruct OA. For many nations, however, it is the more practical issues involved in operationalising OA policies that pose the real challenge. While the costs of establishing research repositories and journal subscription are significant, there are now some programs such as Research4Life that facilitate OA. In examining some of the challenges of OA, this paper focuses on how a clear, consistent and equitable approach to the releasing of research and data is fundamental to OA.

In particular, the paper will highlight that a key element of OA is the education of, and support for, the research community. In order to mark this argument, the paper draws from a range of sectors that, having already adopted OA policies, are now focusing on operationalising OA in a way that enables researchers and their institutions to embrace OA at the grass roots level.

**Transcribed plenary speech of Associate Professor Leanne Wiseman.**

Today I'd like to speak to you about open access movement that has been gathering momentum probably for 25 years now, and in the past decade has become more accepted by governments and public organisations.

And I'd like to look at opening access to knowledge through the perspective of the research institutions and research communities who are often a slightly lost voice in the open access movement. So opening access to knowledge has been justified on the basis that the full social and economic benefits of research should be available to everyone, particularly public funded research as everyone should be able to use research to improve their society and their lives and most people would accept this as a good thing. So we see across the world internationally the primary features of free and unrestricted underlying value of research in a wide range of international policies, frameworks, guidelines.

Many of these guidelines and policies we are seeing in govt and international organisations always tend to highlight the fact that law is one of the main barriers that hinder or obstruct the open access to research and data and in particular those laws; intellectual property is the most common reason people get for barriers to opening access and in particular the regimes of copyright law, copyright licenses over databases pose particular problems for researchers so in certain instances patent law where info is locked up within patents.

The other areas of law are privacy and confidentiality laws and in some case the issues of national security. All of these reasons have been cited by institutions and by funders and researchers as reasons why they cannot release knowledge into the public domain and make it

freely available to others to use. But for many publicly funded organisations it's important to understand what intellectual property is and that is really the 1st step they need to take. For research institutions, the focus has been on the institutional structures and policies and strategies they can implement to support their researches.

The need for intellectual property policies that are up to date, and also, we are seeing an increase in the no. of open access policies that accompany copyright policies in research institutions. To have a good understanding of the intellectual property that the researches are developing and what attitude the institution will have to opening that research and knowledge to others is fundamental. The development of intellectual property offices within research institutions and having dedicated staff to assist with the education and capacity-building among the research community about the intellectual property and the value that can bring to the world community. One of the most significant costs of accessing freely available info of many countries and institutions is the actual cost associated with the databases where publishers have locked-up the information.

The fees tend to be adsorbent and this is one of the barriers encountered by research institutions but there are increasing programs such as Research4Life that are helping developing nations gain access to publications that are locked-up by commercial publishers. So, for research institutions many have had to undergo a change to refocus on the needs of their researchers and how best to foster their research initially and to develop that intellectual property into publications that they can then put out into the public domain. So, what are the practical tools for researchers that could be developed to assist them maintain and honour these access mandates that institutions have been imposed upon them universally.

The fact is that the researches would be better available to compile their open access if attention was refocused on the actual role the researchers play in making that research open and the underlying data openly available. What I'd like to do is basically look at the future trend of open access and its focus has very much been on compliance. Most govts and institutions have acknowledged that open access is a public tool but how to ensure that is actually happening at the grass-root level.

When looking at compliance I just like to use the agricultural context and look at 2 very large research-

funders that work in public space in agricultural research, particularly in developing nations and what they have done for their researches to help them comply with open access mandates that they have posed. Firstly the Bill Gates foundation.

This is just a sample of some of the press that has built up on the Bill and Melinda Gates foundation when they announced in 2014 their open access policy. Basically if you accept their funding then all publications must be made open access under their terms. The aims of the Gates policy basically have 5 elements and these that all publications result from Gates funding must be discoverable, accessible, they must be published on open access terms, they must be open immediately and there is no embargo as with other mandates, and the underlying data to the research must also be accessible and immediately as well. What is very interesting and perhaps reflective of the position of the Gates foundation is that the foundation has taken it upon itself to pay all Intellectual Property (IP) processing fees associated with publishing open access journals. So, the Gates policy is not negotiable, if you take their funding you must release your data immediately with no exceptions, and whether you receive part or full funding, you must comply by the mandate.

Their aim is to achieve 100% compliancy as soon as possible. To assist their researches, they have developed a web-based platform that is directly available to their researchers to help them negotiate the application process. In July 16th Pronos was developed by the Gates foundation and this directly assists with putting their research into open access fields. Gates have been very influential in speaking to other public funders and they have developed the open funders group which is essentially a partnership of funding organisations committed to open sharing of research.

Their aim is to accelerate the pace of discovery and reducing the info sharing gaps particularly encouraging and promoting innovation interests. So, they are working together to establish similar open access policies in other large funding organisations. Another large public funder in the agricultural sphere in developing nations is the consortium of international agricultural Centers research (CGIAR). They made a strong movement towards opening access to their research and they have 15 research centres located in different countries around the world. When they adopted their principles on management of intellectual assets in 2013, and it was there that they signalled free access to all their activities. In conjunction

with the intellectual principles they introduced their data management policy. What's interesting about the CTIAR is they don't see intellectual property as a barrier to release of info, because their focus is not on the method of disclosure, rather on the consequences of the disclosure. So in some instances intellectual property is actually one means by which info and knowledge can be delivered and there have been many examples with info that is patented, where patent has actually helped the distribution of knowledge and not a barrier.

The challenges for the CTIAR are that they have 15 research centres in developing nations around the world. There's a distributed governance arrangement so each area has a different web-based platform and none of them speak to each other, so this is a huge challenge for CTIAR to consider opening access to research. Importantly researchers who were interviewed and these issues discussed, it was the fact that there was no incentive to make their publications openly available, there's no reward in their promotion structure, nor were they given recognition for publishing. They also recognised the valid legal issues of confidentiality and also IP rights. What's

interesting to observe is that there's genuine effort in the last year to help researchers have open access and this is just some of the help the CTIAR have been given their researchers.

They have developed support packs, also guides about which journals to publish in as well as fact sheets and accompanying material to help raise awareness within their research community. They have gone through a similar approach to providing aid at the grass-roots level researchers to ensure that they are helped as much as possible to raise open access so that they will get the benefit along with their peers.

We're seeing institutions focussed on developing practical tools to help their researchers. Education is happening in undergraduate programmes about what intellectual property is and its value to researcher's focus has been placed on the awareness rising of the principles of open access, and support for early-career researchers. These are just some strategies institutions are employing to ensure that researchers are now becoming the focus of the open access movement.



# INTERNATIONAL LAW & JUSTICE: SOME PRELIMINARY THOUGHTS ON A STRAINED RELATIONSHIP

**Dr K Senaratne**

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**Abstract** -International law is often considered to be a discipline meant to promote justice. The story of international law's historical evolution tends to be generally associated with events which are celebrated as having advanced the cause of justice, and modern international law's key instruments embody the strong desire for promoting and preserving justice and peace. But this is only one part of the story. A more dispassionate reading of international law's historical evolution shows that its origins and development had little to do with the notions of justice and fairness. How could this be so? And how may we think about international law's role and relevance in a troubled world, if we realize that the relationship between international law and justice has always been, and will always be, a strained one?

## Transcribed plenary speech of Dr Kalana Senaratne

The theme today raises a number of questions for international law students. It raises the critical question of the relationship between international law and justice. Questioning the relationship between international law and justice has always engaged great minds. International law and justice follow each other very closely. If you read some of the books and articles on international law, you might see that the two concepts go together. It's almost as if, at times, you cannot talk about one without referring to the other.

It is an issue which is affecting a lot of people around the world, including the people of Sri Lanka. Many stories can be told about this relationship. One is somewhat mainstream and very optimistic. This is about the positive relation between international law and justice. According to this story, the roots of international law go back centuries to the religious teachings. There is reference to

teachings in Hindu, for example. This story also refers to the idea that the development of international law principles is slow.

There is the reference to something called where European states and entities got together to end the 30yrs war, which was a big problem in international law in form of treaties made to prevent the recurrence of war. I will also talk about the great thinkers of IL such as Hugo Grotius, people who were first talking about international law in the scientific manner. Then you get to the birth of international law and institutions.

There is a reference to the development of principles such as international humanitarian law (IHL). The late 18th, late 19th and early 20th centuries give reference to the roots of these humanitarian principles, in institutions such as the ICRC and also the various peace conferences, and in all these there is some attachment to the idea of justice. Especially in the form of IHL, which is largely about insuring justice to the people affected by war and conflict? You then get to what is sometimes known as the heroic period of international law, from the 1920s up to about the 1960s. There is firstly a new hope promoted by a president of the US, Woodrow Wilson.

He was talking about a new world order based on states which were made up of consent to be governed, a great promoter of international law and justice, and in particular the principle of self-determination. Steps were taken to establish something like the world government, not a government really but small steps were taken in that direction. The League of Nations was established. We find international judicial bodies being established, the Court of International Justice. We find the great ideas of the international criminal law which had to do about justice ultimately being discussed by the great idealists and great

international law scholars. Then you get the US system, which is the foundation of the current international legal and political court. Its main purposes are to maintain international peace and security and to end disputes in conformity to the principles of justice and international law. There again international law and justice seem to be going together. Look at the Nuremberg charter, again about justice. Promoting justice to people affected by World War II.

We also talk about decolonization. International law helps a large number of people in the third world to attain freedom from colonial rule. The principle used here was the right to self-determination in international law. After a period of about 30-40 years in which nothing much happened, in the 1990s we find rejuvenation in international legal literature.

The cold war was over, leaving a lot of literature about internal self-determination, promoting a democracy and people's justice. New tribunals were established the Rwandan tribunal, again to promote justice to the people. The ICC comes about. More recently we have the nuclear banning treaty. Another wonderful moment said to have promoted the course of justice and peace around the world. In this way the story suggests that things are easy, which it certainly is not. But we are slowly getting there as by the words of justice Weeramantry; "we are perhaps moving towards the sunlit plateau of peace and justice". But is this the only story to be narrated about international law? There is another darker story we should be mindful about. This darker story is not the complete opposite, it tells that international law may be about promoting justice as well as injustice and at times it may be difficult for some of us to differentiate between the two.

This is always the case. We can refer to the moment when the idea of the international community was promoted; 1648. This was about stopping the recurrence of war. Ask the question from the perspective of justice, what of the people who were subjected to a brutal war? This was a moment where no one judged the people who fought; it was largely about preventing and not really about justice. Take the early principles of international law, and international law can be seen as not something that prevented, but as something that promoted colonialism. Take the work of some leading scholars such as prof.

Tony Anghie, who laid out the principle of sovereignty, which is central to international law, as a way of ensuring the distinction between the sovereign and the less

sovereign and non-sovereign. Between the civilised and the uncivilised. The question we don't ask about these principles is who decided one part of the world is considered sovereign and the other not sovereign? What did international law say about the justice to people of the world at that time? International law principles helped the promotion of colonialism. There were concepts developed, *Terra nullius* is one concept that comes to mind, the idea being that territory doesn't belong to anyone. You enter these territories, take hold of them and there's another international law principle which tells that you cannot prevent or resist colonization, there could be a war justly waged against. That was international law those days. Self-determination. Popular story was that international law helped decolonization. That international law granted self-determination to people. But was that really the case? Who decided in the 1st place that certain parts of the world were not qualified enough to self-determine? These questions are not really asked by a lot of people.

Take the moment the UN was established, and there's a wonderful irony here that does not appear without a bit of probing. This was one of those great see-saw moments in the development of international law and international legal order. The UN charter was signed on the 26th June 1945. And why was that? There were a lot of things about international law said in the UN charter to prevent recurrence of conflict. On the 6th August Hiroshima was hit, after the UN charter was adopted. Two days later we get the Nuremberg charter which considered many activities illegal. On the 9th August we get the bombings of Nagasaki. What of justice in this particular context? How do we understand the concept of international law and justice in this way? When we talk about the Nuremberg structure but Nuremberg was also one of those moments where, if you observe critically, you doubt whether there should be a constitution in the 1st place. The critical history of Nuremberg tells you that when this issue came up in 1945 that Britain and Churchill in particular were against the idea of prosecuting, and they had wanted some of the main Nazi leaders executed. Because he knew the irony of establishing tribunals and getting the accused to speak.

They knew it might be a short trial, at the end. Why was the Nuremberg plan executed? Well it was mainly because President Roosevelt thought the people would like it. Stalin thought it has great propaganda effect. So this is also the story of international law and justice. We talked about nuclear weapons. It's nice to have a treaty but it seems that almost all countries of the world will accept it somewhere

in the future except for a few states which have nuclear weapons. If you ask international law the critical question; does international law make nuclear weapons illegal? Even when the very existence of the state is under threat? I don't know what international law will say. I will conclude by referring two or three factors which suggest why this relationship is a difficult one.

One is because the nature of international law is such that it makes it difficult for people to achieve justice because international law on the one hand has respect for state interest since the subject of international law is still the state and states operate on very different principles of sovereignty, territorial integrity, security etc. But international law also has to respond to the concerns of the individual human rights and individuals operate on a very different set of assumptions, freedom, and liberty and so on. So there will always be the clash between international law and justice.

What about justice? What does justice mean? Justice could be many things to many people. Even since the ancient Egyptian kings justice was something that is defined in the way that a person wanted to define it and the ancient kings considered that what was just was what the Pharaoh considered to be good.

Even today if you ask anyone about justice they would say something very different to what we think of justice. Finally justice is unpredictable because you may think you want certain things but once that is realised you might think there is something more to be attained. I think it somewhat unfair to demand international law to promote justice all the time because international law is ultimately a modest tool we make by ourselves and therefore we cannot expect to prove anything with international law. I think the question that will always have to be asked is what international law are we talking about? And whose justice are we talking about? The moment we start looking for answers to these questions, we know the relation between international law and justice is not going to be a very happy one.

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*Technical  
Session*

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(ORAL & POSTER PRESENTATIONS)

# DOES SRI LANKA NEED A SYSTEM FOR REGISTERING GEOGRAPHICAL INDICATIONS?

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**Abstract** – Recent reports published in Sri Lankan newspapers suggest that local industries (particularly Cinnamon producers) have raised concerns about the lack of a registration system for Geographical Indications (GIs) in Sri Lanka. They have even gone on to suggest that the failure on the part of Sri Lankan authorities and stakeholders to obtain protection of Sri Lankan GIs in other jurisdictions (and in particular the European Union) is attributable to the lack of a domestic mechanism for the registration of GIs.

Both local industries and academics have made reference to the Indian approach on the registration and protection of GIs and have called for the implementation of a similar system in Sri Lanka. It was in order to address this specific concern and plea that the Cabinet of Ministers by a decision made in October 2016 pledged to amend the Intellectual Property Act 2003 (IP Act), which governs the protection and enforcement of Intellectual Property Rights in Sri Lanka.

Yet, contrary to expectations and adopting an approach that is much less comprehensive than the existing legislative approach in India, the proposed amendment to the IP Act merely introduces a single sub-section to s161 that deals with the protection of GIs.

In this backdrop, this paper deals with the following points. First, the paper considers whether the current regime for the protection of GIs in Sri Lanka is sufficient in order to obtain the necessary legal protection for Sri Lankan GIs both locally and globally. Second, the paper critically assesses the new amendment to the IP Act, comparing it with the Indian approach, in considering its practicality and utility. It is argued that the new amendment adds nothing to existing law.

**Keywords** - Geographical Indications, Registration, Protection, Certification marks

## I. INTRODUCTION

The objective of this paper is to consider a very specific question – that is, whether Sri Lanka needs a system for registering Geographical Indications (GIs or GI in singular). The Intellectual Property Act 2003 (IP Act) defines a GI in s103 as “an indication which identifies any goods as originating in the territory of a country, or a region or locality in that territory, where a given quality, reputation or other characteristic of the good is essentially attributable to its geographical origin.” In recent times, industries that rely on GIs to promote their goods globally have raised concerns about the lack of a registration system for GIs in Sri Lanka.

For instance, the Spices and Allied Products Producers’ and Traders’ Association, which represents the interests of Cinnamon producers, has taken the view that “GI registration will not only help [producers] to market and promote Sri Lankan spices and allied products but also to safeguard them against the violators of the law in the international market” (Daily Mirror, 2014). In fact, local industries have attributed delays in obtaining protection of local GIs in other jurisdictions, such as the European Union (EU), to the lack of domestic GIs register (Daily Mirror, 2016).

The plea on the part of local industries for a GIs registration system is also supported in academic discourse (De Silva, 2015; Wijeshinghe, 2015; Pathiraja, 2016). For instance, Wijeshinghe (2015, p23) has suggested that providing a proper system of domestic registration is a fundamental requirement for a successful GIs regime and that

protection must at least be extended with registration procedures facilitating the sound legal protection of all products which have intrinsic qualities inherited by their place of origin. In a similar vein, De Silva (2015, p46) has suggested “at least to grab the available protection in the countries where there is a good market for Sri Lankan GIs, a registration system would provide a suitable mechanism to the country.” More recently, Kamardeen (2017, p.410) has argued that “Sri Lanka could, and perhaps should, consider improving its current GI regime by implementing a national GI registry.” Those who claim that Sri Lanka should embrace a system of GIs registration make reference to the Indian legislative approach that provides for registration system for GIs (De Silva, 2015; Wijesinghe, 2015; Pathiraja, 2016; Kamardeen 2017).

These assertions and pleas in support of a GIs registration system for Sri Lanka made by local industries, as well as academics, have acted as the impetus for the Sri Lankan Government to take the initiative to propose an amendment to the IP Act, which governs the protection and enforcement of intellectual property in Sri Lanka, including GIs.

Thus, in October 2016, a proposal put forward by the Minister for Industry and Commerce to amend the IP Act to provide for the registration, certification and protection of GIs, was approved by the Cabinet of Ministers (Daily News, 2016). This decision was highly commended by the local industrial community – eg stakeholders representing the cinnamon industry have observed that “[t]his measure will pave the way for certification of cinnamon products originating in Sri Lanka with regard to GI which is a necessary step for international registration of ‘Ceylon Cinnamon’ to benefit from GI which is the highest level of protection” (Daily Mirror, 2016). Yet, contrary to expectations and adopting an approach that is much less comprehensive than the existing legislative approach in India, the proposed amendment to the IP Act merely introduces a single sub-section to s161 that deals with the protection of GIs.

In this backdrop, this paper considers the following points – that is (1) whether the present regime for the protection of GIs in Sri Lanka is adequate in protecting the rights and interests of local producers of GI-related goods and (2) whether the proposed amendment to the IP Act adds anything in substance to the existing legal framework for the protection of GIs in Sri Lanka. A discussion of both these points is required to comprehensively respond to the question that this paper poses—that is whether Sri Lanka

really needs a GIs register that registers and protects GIs as such.

In terms of methodology, the paper adopts a strictly doctrinal and comparative approach. Doctrinal because it engages in analysing the law as it is in relation to the protection of GIs. Comparative because the paper refers to the Indian approach to GIs protection in supporting the conclusion that Sri Lanka does not gain any additional benefit in introducing a separate and distinct register for GIs.

## II. THE ADEQUACY OF THE LEGAL FRAMEWORK IN SRI LANKA FOR THE PROTECTION OF GEOGRAPHICAL INDICATIONS?

Before dealing with the proposed amendment to the IP Act, it is apt to consider the current provisions in the Act that protect GIs and their adequacy. Reference must first be made to sub-section (1) of s161 of the IP Act, which provides that “any interested party” shall be entitled to prevent (1) the use of any means in the presentation of goods that indicates that the goods originate in a geographical area other than the true place of origin in a manner which misleads the public or (2) any use of a GI which constitutes an act of unfair competition or (3) use of a GI identifying goods not originating in the place indicated by the GI (even where the true origin of goods is indicated) or use of a GI accompanied by words such as like, style or imitation. This provision permits any interested party (which no doubt would include producers of GI-related products) to prevent the unauthorised use of GIs by third parties in the circumstances identified therein. The first two limbs of s161(1) comply with Art.22(2) of the Agreement on the Trade Related aspects of Intellectual Property Rights (TRIPS), to which Sri Lanka is a party. The third limb of s161(1) confers greater protection than what is required by TRIPS (Art.23(1))—as protection under that limb extends not only to wines and spirits but also to other goods including agricultural products and foodstuff. There is no requirement for a GI to be registered for an action under this provision to be instituted (Karunaratna, 2010, p299).

In addition, GIs may be protected as certification marks (or as collective marks). The Sri Lanka Tea Board (SLTB) has protected the interests of tea producers by registering

the 'Pure Ceylon Tea' logo as a certification mark. Section 142(1) provides that "[s]ubject to the provisions of this Chapter, provisions relating to marks shall apply to certification marks." In essence, once a GI is registered as a certification mark, the owner of that mark may prevent unauthorised third parties from using the GI in ways that would cause confusion or mislead the public, a remedy that is normally available to trademark owners.

The general prohibition against the registration of signs or indications denoting the geographic origin of goods as trademarks has been made specifically inapplicable to the context of registration of certification marks, enabling the registration of GIs (s142(2)). However, this exception to the general prohibition on the registration of geographic signs is subject to one limitation.

That is, "the owner of such mark is not entitled to prohibit the use of such sign or indication in accordance with honest practices in industrial or commercial matters and in particular by a person who is entitled to use a geographical name" (IP Act, s142(3)). Yatawara and Rajapakse (2009, p13) citing the example of 'NUWARA ELIYA TEA' (which is registered as a certification mark by the Sri Lanka Tea Board) identify this as a significant drawback—"Nuwara Eliya is a geographic name of a district in Sri Lanka.

Therefore, if "Nuwara Eliya" is registered as a collective or certification mark for tea, it nonetheless cannot prevent other tea originating in Nuwara Eliya from being described as "Nuwara Eliya Tea", even if such tea does not meet the requisite quality or characteristics set by the mark owner as a condition for the use of the registered mark" (emphasis in original). This scenario is certainly not an impossibility. In terms of the specifications provided by the SLTB for Nuwara Eliya Tea, in order to qualify to use the mark, tea growers must meet certain quality standards and grow their tea within the Nuwara Eliya agro-climatic zone. Figure 1 below reproduces the Nuwara Eliya certification mark. Figures 2 and 3 set out the Nuwara Eliya agro-climatic zone and the administrative districts in Southern Sri Lanka respectively.



Figure 1.



Figure 2.



Figure 3.

As is seen from figures 2 and 3, the Nuwara Eliya agro-climatic zone (the area marked black in figure 2) within which tea must be grown in order to become eligible for the use of the Nuwara Eliya certification mark (figure 1) is a much smaller region within the Nuwara Eliya administrative district. Yet, anyone producing tea within the Nuwara Eliya administrative district (but outside the Nuwara Eliya agro-climatic zone) may legitimately be entitled to use the phrase 'Nuwara Eliya' on the packaging of the products to designate the origin of their products. What Yatawara and Rajapakse (2009) have suggested is that such use cannot be prevented by the producers of Nuwara Eliya tea grown according to the specifications of the SLTB and in the Nuwara Eliya agro-climatic zone.

This is so even if the third party's tea products do not meet the same quality or characteristics of tea authorised to bear the GI. In such an event, it might be the case that the only remedy that is available in the interest of users of a GI is the remedy enshrined in s161 of the IP Act, rendering the registration of GIs as certification or collective marks completely useless.

However, Yatawara and Rajapakse (2009) may have overstated the problem. The limitation on the right of exclusion conferred on certification mark owners in terms of s142(3) of the IP Act concerns the use of a mark by a third party “in accordance with honest practices in industrial or commercial matters.”

This is the exact language that is adopted in s160(1) (a) dealing with unfair competition. Notably, unfair competition includes the use of protected marks in ways that causes “confusion with respect to another’s enterprise or its activities, in particular, the products or services offered by such enterprise” (s160(2)(a)). Arguably, a person who is “entitled to use a geographic name” as referred to in s142(3) must do so in accordance with honest practices.

Accordingly, although a tea grower in the Nuwara Eliya district (outside the Nuwara Eliya agro-climatic zone) would be in principle entitled to utilise the phrase ‘Nuwara Eliya’ to describe the products concerned, the use of the phrase cannot in any way confuse or mislead consumers to believe that the goods in fact originate from the agro-climatic zone to which the Nuwara Eliya certification mark relates.

Even assuming that Yatawara and Rajapakse (2009) are right in their assertions, that does not necessarily mean that GIs are not adequately protected in Sri Lanka. After all, as stated earlier, TRIPS plus protection is afforded to GIs by virtue of s161 of the IP Act (although not through a process of registration). Yet, if GIs are adequately protected in Sri Lanka, why have local industries lobbied for a system for registration? The answer to this question rests on the fact that local industries perceive domestic registration of GIs as a necessary prerequisite for ‘international registration’ of local GIs. This perception, however, is misconceived.

First, no local GI can obtain ‘international registration’ (at least for now), as Sri Lanka is not a party to the Lisbon Agreement on Appellations of Origin 1958. Art.1(2) of the Agreement provides that contracting parties “undertake to protect on their territories, in accordance with the terms of this Agreement, the appellations of origin of products of the other countries of the Special Union, recognized and protected as such in the country of origin and registered at the International Bureau of Intellectual Property...”

Had Sri Lanka been a party to the Lisbon Agreement 1958, it would no doubt have made sense to incorporate a domestic registration system for GIs, as registration would have been necessary for the recognition and protection

of GIs as such in the country of origin—a prerequisite to obtain ‘international registration’.

Thus, unless Sri Lanka joins the special union comprising the signatories to the Lisbon Agreement 1958, the perception that domestic registration of GIs leads to ‘international registration’ is completely mistaken.

In any case, at present, gaining membership to the special union of the Lisbon Agreement 1958 would not provide Sri Lankan producers of GI-related goods a significant advantage, as only 28 countries have acquired membership to the special union thus far. It has been suggested that the Lisbon Agreement 1958 has not become a popular choice because “it protects appellations of origin only when they are officially acknowledged by the country of origin” (Stoll et al, 2009, p22), requiring GIs to be registered in the countries of origin—whereas many countries do not provide for a system for registering GIs as such. In addition, why the Lisbon Agreement 1958 has been unpopular may be attributed to the narrow scope of the treaty in terms of what can be protected—ie appellations of origin. In contrast, GIs are broadly defined—appellations of origins capable of being regarded as a type of GI. Notably, in May 2015 the Geneva Act to the Lisbon Agreement on Appellations of Origin and Geographical Indications was adopted, which extends protection to GIs (in addition to appellations of origin).

It is thus, speculated that a greater number of states will become party to the Geneva Act. In these circumstances, it is advisable for the Sri Lankan Government to take steps to become party to the Geneva Act. Under the new regime, GIs may be registered directly in an international register through an international bureau established under the Geneva Act (Art.4). In the event Sri Lanka does someday become a party to the Geneva Act, international registration of local GIs may be obtained without the need for a local register.

Second, and as things presently stand, Sri Lankan GIs have to be individually protected in every country in which there is an interest to do so.<sup>1</sup> In some countries protection may only be obtained by registering the GI in that country (eg India). Whereas, in others, no registration is required (eg Singapore).

In either case, however, it is permitted under TRIPS for Member States to require that a particular GI in relation to which protection is sought be ‘protected’ in the country of origin (Art.24(9)). Notably, ‘protected’ does not mean



‘registered’ as such (Wijesinghe, 2015). Thus, it would suffice that a GI is registered in the country of origin as a certification (or collective) mark to be protected both in the country of origin and in the other country where protection is sought.

There is also a perception on the part of local industries that the domestic registration of local GIs is capable of expediting the process of acquiring protection in other jurisdictions. The trigger for this perception was the difficulties and delays Sri Lankan authorities faced in obtaining protection for local GIs abroad, particularly in the EU (Daily Mirror, 2016).

These difficulties and delays arose in view of the equivalence and reciprocity conditions that were imposed under Art.12(1) of Council Regulation (EEC) No 2081/92 of 14 July 1992 on the protection of geographical indications and designations of origin for agricultural products and foodstuffs (Regulation 2081/92). Accordingly, in order for GIs from non-EU states (third countries) to be registered and protected in the EU, third countries were required to adopt a GI protection system equivalent to that in the European Communities and provide reciprocal protection to products from the European Communities. Since the EU adopted a registration system for GIs, this meant that unless a country outside the EU had in place a domestic system for the registration of GIs, no GIs from that country could be registered in the EU.

Hence, the implementation of a local GIs register would have been useful in order to comply with the equivalence and reciprocity approach adopted by the EU in Regulation 2081/92 (Art.12(1)). Yet, in 1999 this aspect of Regulation 2081/92 was challenged by the United States (US) in the World Trade Organisation (WTO) on the basis that the requirement flouted national treatment obligations under Art.3:1 of TRIPS.<sup>2</sup>

The dispute was decided in favour of the US and the WTO Panel’s report was adopted on 20 April 2005. A new Regulation 510/2006 was enacted replacing Regulation 2081/92 in order to comply with the outcome of the WTO dispute. Notably, Regulation 510/2006 provides that GIs of non-EU states may be registered provided there is “proof

that the name in question is protected in its country of origin” (Art.5, emphasis added). Thus, under the present regime, the registration of a third country’s GI in the EU’s register does not depend on whether the GI is registered in the country of origin—it would suffice that it is protected, such protection being achievable through the regime for certification marks. In fact, it is likely that any attempt to impose a requirement that a GI must be registered in the country of origin in order for it to become eligible for protection (or registration) in another country would flout the national treatment provision in TRIPS.

Fourth, academics supporting the introduction of a GIs registration system in Sri Lanka have referred to Indian legislation. Yet, it must be noted that the protection afforded to GIs under s161 of the IP Act is precisely the same in terms of scope and substance to what is afforded to registered GIs in India under the Geographical Indications of Goods (Registration and Protection) Act 1999 (GIs Act 1999). Thus, the level of legal protection of GIs in Sri Lanka is on par with India despite the lack of a system for registering GIs as such.

Accordingly, for the above reasons, there is no necessity for the introduction of a registration system for GIs in Sri Lanka, from the perspective of obtaining legal protection for domestic GIs both locally and globally. Instead, the recommended course of action for Sri Lanka would be to become party to the Geneva Act, which would enable local GIs to be directly registered in an international register—which in turn results in protection being acquired in all countries party to the Geneva Act.

### III. THE AMENDMENT PROPOSED TO THE IP ACT

What this paper seeks to stress is that a domestic GIs register is neither a prerequisite, nor a necessity, to secure a requisite level of legal protection for Sri Lankan GIs both locally and globally.

This does not mean, however, that the introduction of such a register does not have its advantages. Kamardeen (2017, p.410), for instance, has suggested that “creating a

<sup>1</sup> This might change if Sri Lanka becomes party to the Geneva Act, where an international registration would automatically allow for GIs to be protected in all state that are part of the special union.

<sup>2</sup> European Communities—Protection of Trademarks and Geographical Indications for Agricultural Products and Foodstuffs WT/DS174/R (15 March 2005), [7.204]–[7.204].

registration-based scheme for GI protection in Sri Lanka could offer additional certainty to GI producers, and in turn competitors and other interested parties who could be made aware of existing GI registrations.” However, the process of registration and maintenance of GIs in a register must be transparent, unbiased and adhere to principles of due process.

The proposed amendment to s161 of the IP Act merely adds a new sub-section. Accordingly, s2 of the Intellectual Property (Amendment) Bill 2017 (IP (Amendment) Bill) inserts sub-section (4A) to s161, which reads as follows— “[t]he Minister may prescribe any geographical indication in respect of any goods or products for the purpose of this Act” (emphasis added). Interestingly, the Sri Lankan amendment is far less comprehensive in comparison to the Indian approach, which many academics have referred to in supporting their claims for a Sri Lankan register for GIs. There are two points that must be made in connection with this proposal.

First, s161(1) begins by permitting “any interested party” to prevent the unauthorised use of GIs on the part of third parties in the circumstances set out therein. However, the IP (Amendment) Bill does not in any manner set out the consequence of the Minister’s act of prescribing a GI. In the event the amendment becomes law, it is unclear whether in future only interested parties in connection with GIs that are prescribed by the Minister can make use of the entitlement to prevent unauthorised third parties from using GIs in the circumstances set out in s161(1) of the IP Act.

If such an interpretation is afforded, the opening words of s161(1) will be rendered meaningless. In contrast, the position in India is far more straightforward—s20(1) of the GIs Act 1999 expressly provides that “[n]o person shall be entitled to institute any proceeding to prevent, or to recover damages for, the infringement of an unregistered geographical indication” (emphasis added).

Second, GIs are collective interests where all producers in the region in which a particular product originates have an interest over a GI (Ganjee, 2006, p112). The collective nature of the interests in GIs is reflected in the Indian GIs Act 1999 when it permits “[a]ny association of persons or producers or any organization or authority established by

or under any law for the time being in force representing the interest of the producers of the concerned goods” (emphasis added) to apply for registration of GIs (GIs Act 1999, s11(1)).

In contrast, the Sri Lankan IP (Amendment) Bill provides that the Minister may prescribe a GI. Yet to what extent does a Minister represent the interests of producers? It is crucial to ensure that the interests of producers of GI-related products are represented during the process of registration and the subsequent maintenance of those registrations.

Government involvement in relation to the maintenance of the GIs register may not be in best interest of those who produce GI-related goods, as the Indian experience suggests (Sally and Suneja, 2016). This concerns the controversy surrounding the Basmati GI.

The Agricultural & Processed Food Products Export Development Authority applied for, and registered, ‘Basmati’ in India as a GI for rice originating in the Indian states of Punjab, Uttar Pradesh, Uttarakhand, Himachal Pradesh, Jammu & Kashmir, Delhi and Haryana<sup>3</sup> (Bharti and Bharti, 2015, p.203; Fromer, 2017, p.151). However, the Government of the state of Madhya Pradesh has demanded that its state be included in the list of states whose producers are entitled to use the Basmati GI.

This move has been criticised in view of the possibility that the quality of products bearing the Basmati GI may become questionable in international markets—eg the Deputy Director of the Indian Agricultural Research Institute has cautioned “[c]laiming rice grown in Madhya Pradesh as basmati is not correct as we have developed seed varieties keeping in mind agro-climatic zones of the Indo-Gangetic plain” (Das, 2014).

Accordingly, it is crucial that governments play an independent and neutral role in determining what indications become included in the register of GIs and the scope of those GIs. Ideally, any legislation (or regulation) dealing with the registration of GIs must provide for the possibility of interested parties (including association of producers) to make representations concerning registrations of GIs. Thus, in Sri Lanka’s case, conferring discretion on a Minister to prescribe GIs could become the

<sup>3</sup> The Indian GIs register is available at: <http://www.ipindia.nic.in/writereaddata/Portal/Images/pdf/Registered-GIs-of-India.pdf> (Accessed: 29.06.2017).

subject of abuse, particularly when the enabling legislation does not provide for a formal mechanism by which interested parties could apply for registration of a GI, or state their objections against a third party's application for registration.

In the circumstances, it is unclear as to what the new amendment really seeks to achieve. Particularly, in view of the fact that 'registration' of GIs as such in a domestic register is not a prerequisite for seeking protection of local GIs in other jurisdiction, one may wonder whether the change that is sought to be made by the IP (Amendment) Bill is of the kind that was imagined and envisioned by local industries and academics.

## IV. CONCLUSION

The purpose of this paper was to consider the utility of introducing a system for GIs registration in Sri Lanka. It was posited that the present regime for the protection of GIs under the IP Act is adequate in achieving a level of legal protection necessary to secure the rights and interests of local producers of GI-related goods.

It was suggested that the Sri Lankan Government ought to focus on gaining membership to the special union of the Geneva Act to the Lisbon Agreement on Appellations of Origin and Geographical Indications so that local GIs may be registered directly in the international register that is envisaged under that regime.

The adequacy of the current level of legal protection and the probable shift to an international register under the Geneva Act render a local GIs register unnecessary and redundant. In any case, if what the proposed amendment to the IP Act seeks to do is to introduce a system for registering GIs, it does so in a problematic fashion—far removed from the expectations of both the industry and academic proponents that support a system for GIs registration.

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# EVOLUTION OF THE DIGITAL COPYRIGHT INDUSTRY: ARE WE READY TO FACE DYNAMIC CHANGES?

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**Abstract** - New digital technology enables people to access multiple forms of creative work regardless of the geographical location of origin. It expands the areas of human creativity from mere literary, scientific and artistic works; up to the multitude of computer based creations including computer software, mobile applications and three dimensional creations etc.

Through the lens of copyright law, this approach sets novel form of avenues for the users to participate in the consumption, distribution and creation of content in a way which is revolutionary for both the culture and the industry. However, from the authors and the point of view of the copyright owner, this development urges a set of new protections to prevent their rights from being violated (infringed).

The main research problem of this paper is explaining whether the existing Sri Lankan copyright law is adequate to protect the rights of the copyright holder and copyright user from the evolving challenges in digital world or should a new piece of legislation be enacted to clearly define their rights in order to prevent digital copyright infringements? The research was conducted following qualitative research method, thus the number of books, journal articles and internet articles were used to gather secondary data on this area.

This research presents an analysis about the existing Sri Lankan law relating to copyright and related rights by examining its adequacy to meet the challenges evolving in the digital world and recommends to adopt new piece of legislation to protect the rights of the whole society to enjoy the benefits derived from day today creations including digitized works, while mitigating unlawful

behaviour which hinder effective enjoyment of the fruits acquired by the copyright holders through their legitimate.

**Keywords** - copyright, entertainment industry, digital economy, digital world

## I. INTRODUCTION

The law of copyright establishes bundle of protections granted over the literary, scientific or artistic works created by the author to ensure further control of his creation (McName J, 2011, P7). One objective of this protection is to safeguard the ideological integrity of the work.

These are so-called moral rights. By following the view of utilitarianism, copyright entrenches economic rights which allow author/copyright owner to reap the economic benefits flow from his or her work (Abeysekara TB, 2013). With the evolution of market economy, copyright took the monopoly approach to serve the growing investment relating to creative industry (Karaganis J, 2015) and its disadvantages were logically justified by the argument that it will serve the society by increasing innovation and competition.

In Sri Lanka, copyright is enshrined in the chapter two of Intellectual Property Act (herein after I.P Act, 2003) and is not the fundamental right guaranteed by Constitution as United States (United State Constitution, Article I, Section 8, Clause 8). Sri Lankan copyright law grants its protection from the moment which the work has been created and cover the wide range of literary, artistic and scientific works including works generated in a digital format; if it is an original work of authorship fixed in a tangible medium (IP Act, section 6).

However, when speaking about the digital rights within the scope of Intellectual Property Law, problem is whether Sri Lanka has the potential to face the evolving conditions put by unpredictable technological growth.

From 1990s, intellectual community started to utilize the evolving information and communication technology to sell, freely distribute and make their works available in the internet (Gunasekera D, 2010). After the period of two decades, fastest growth of communication presents us the millions of online information stores as borderless platforms that can be accessed from any part of the world. On one hand, those platforms introduced novel experience to the intellect community by exchanging information across the world in a greater speed. On the other hand, it expanded the potential of ignoring the fundamental rights of the creator, to have their work honored and not changed or distorted and to receive their appropriate economic return. However, it is essential to understand about the conceptual mismatch between tangible work and its digital environment, in order to recognize the ever fluctuating nature of internet related copyright law.

### Methodology and Experimental design

The research methodology of this work will be mainly a qualitative one and a number of books, journal articles and internet articles were used to gather secondary data on this area. The experts from both the fields of law and information and communication technology were interviewed with a view to get their view points in order to see a possible expansion of the definitions and the interpretations of the terminology involved in this research.

## II. RESULTS AND DISCUSSION

Present Sri Lankan copyright law reflects most of the "Berne Doctrinal" values and limits. The scope of its protection to the original face of expression, but Setup Avenue for the rest of the community to build upon the idea and information conveyed by the work (Kumarasena v. Data Management System, 1987 2 Sri LR 190). However, it provides grater monopoly to the copyright owner to reap the economic benefits flow from his investment and provides exclusive rights to carry out or authorize another party to carry out commercial activities in relation to the copyrighted material. On one hand, some of this represents the right of copyright owner to protect technical integrity of his or her creation.

These include right to reproduction (I P Act, Section 9(1)(A)), translation I P act section 9(1)(B)), adaptation, arrangement or other form of transformation (I P Act, Section 9(1)(C )), of the work. On the other hand, copyrights embodied set of rights which avail to limit widespread copying of the work and its unauthorized public usage (Princeton University Press v. Michigan Document Services, Inc. (6th Cir. 1996)). This includes right of public distribution(IP Act, Section 9(1)(D)), public display(I P Act, Section 9(1)(G )), public performance(I P Act, Section 9(1)(H )), and right to authorize or prohibit commercial rental to the public of their original or a copy of the copyrighted work(I P Act, Section 9(1)(E )).

Referring to the aforementioned purposes, Sri Lankan law defines reproduction as, "making of one or more Copies of a work fixed to any tangible medium, and include even any permanent or temporary storage of a work or sound recording existing in electronic form"(I P Act, Section 5). Therefore, it shows that our law considers even a temporary copy of an electronically formed material as reproduced and it becomes a violation unless it conducts either with prior authorization or non-commercial purposes. In Internet language, any upload, download or peer to peer transfer of data fulfils the test of reproduction, and it creates a violation unless the activity is authorized by license agreement. Unlike the general prohibitions bearing on works fix to the tangible medium, in digital copyright schemes, ancillary rights entrench with Digital Rights Management(DRM) techniques play a vital role by allowing copyright owner to continuously impact on the content which has being already sold.

For an example, e-books contend DRM which prevents reader from copying or sharing the e-books even for non-commercial purposes. Furthermore, such measures can limit the number of computers onto which a particular file can be copied. In United Kingdom, when 3GA introduced digital music player with internal storage, the Advertising Standard Authority(ASA) ask 3GA to change the way it advertises and ordered to inform people about the copyright infringement if they make unauthorized copy without appropriate permission. More clarifications with regarding the unauthorized digital copying was given in UMG Recording Inc. v. MP3.com, Inc., 92 F. Supp. 2d 349 (S.D.N.Y. 2000), there the U.S Southern district Court of New York held that while creation of MP3 files violating the reproduction rights, posting of them on an electronic media violates public performance rights and allowing people to listen to the files violates the distribution rights either (Steetle S, 2000). These examples clearly shows that

DRM could impede users from moving music or audio visual work from one device to another even after having been paid. This novel existence of digital rights create direct clashes with Sri Lankan copyright law which well establishes the right of physical owner[user] of the copy of copyrighted material to sell, lend or give away the copy to someone else 'first-sale doctrine' (I P Act, Section 9(4)) as a fence between copyright user and the owner to prevent user from being unnecessarily controlled. *Kirtsaeng v. John Wiley and Sons* 568 U.S. (2013).

Nevertheless, DRM measures also somewhat justified by two evolving factors. On one hand, those exclusively deal with right of copyright owner to involve in legitimate business. And on the other, DRM retaliate against copyright pirates and provide delightful platform to mitigate uncertainty built by the practices in the digital environment. However, as pointed out by Lawrence Lessig, in order to promote free copyright culture, deviate from traditional battle of copyright user v. copyright owner, the DRM measures should have interplay with existing legal developments (Lessig L, 2010). Such a system would be strengthened by enabling simpler and clearer path from all rights reserved system to some rights reserved system, which is somewhat similar to the existing creative commons and free art license that offer creators a wide range of permissions that they can allow on reuse of their work. The Attachment of this license lets anyone who sees it know immediately his rights regarding use and copy of the work, and which simply refrain authors from taking any action against content users based on copyright infringement. For an Example, *jamendo.com* (<https://www.jamendo.com/Result> details, accessed 03-11-2017) is an online music platform where all the works are covered by either a creative commons or a free art license. It has a repertoire of over 55000 albums, offering artists the opportunity to share their art with the world.

Apart from the issues pertaining to the user's right to access the content, again a problem arises about the extent which he/she is allowed to reuse the copyrighted work. In United States, Legal scholars define this as the right of derivation (Gervise D, 2013), But Sri Lankan copyright law address it as three separate rights as the right to translation, adaptation or any other arrangement or formation of copyrighted materials(I P Act, Section 7(1)). Simply, right to derivation allow people to go for their own creation based on the work existing in the society, but the ultimate work must show minimum level of creativity and originality in comparison to the form of pre-existed work (*Feist Publications v. Rural Telephone*

*Service Co.* (6th Cir. 1996)). In Sri Lanka, originality concept based on substantive test and similarity test which preliminarily examine whether the substantial way of expression attached to the work is copied or not (*Vasanth Obeysekera v. A.C. Alles*, C.A. no 370/92(F) unreported). United State copyright act (17U.S.C. 101(2006)) applies rather strong solution to the issue and define derivative rights very broadly as a right to prevent the making of any work based upon a pre-existing work. Nevertheless, by extending its protection up to the non-literal parts of the creation, U.S copyright law creates complete overlap with the "idea-expression" dichotomy and leave very little portion of the work to the rest of the society to develop upon its emergence. French law in this context is slightly different and it enshrine the rights of the author and believes that their property is mostly justified, since it flows from their intellectual creation (Mazeh, Y). However, unlike the Sri Lankan and U.S copyright laws, French legal approach to the copyright provide notable value to the human creativity, but again become futile in balancing the rights of the Author, Copyright owner, and the content User as the three pillars of the existing copyright sphere(Jayawardena D.S.R, 2014). As Gervais precisely noted, as the right lay on the essential border between infringement and inspiration, there is a need for inevitable steps to clarify derivative rights within the doctrinal and normative context in emerging digital economy (Gervais D, 2013). More specifically, here the fundamental challenges are two-fold. First, it requires good understanding about the existence of derivation in internet sector to define the derivative right properly, and secondly to develop the test to implement the right thus delineated.

In order to get ready to prepare for the aforesaid dialectical challenges, present law relating to translation and adaptation must have to be carved out (Gervise D, 2013). Otherwise, the legislative definition of derivative work and the inclusion of a derivative right become meaningless

Furthermore, under the Intellectual Property Act, copyright owner is granted the right to authorize or prohibit commercial rental to the public, of original or copy of his work (I P Act, Section 9(1)(E)). Even TRIPs constricts its scope in to the computer software and the works relating to cinematography in this respect (Agreement of Trade Related Aspect of Intellectual Property (TRIPS agreement) Article 11), our copyright law stand one step forward and extends right to prohibition of a commercial rental up to the audio visual works and the works embodied in a sound recording.

In order to further compliance with TRIPS, Act leaves computer programs otherwise the program is itself is not the essential object of the rental (IP Act Section 9(3)). US copyright law was entrenched similar protection since the period prior to the TRIPS agreement and therefore, if any transfer of phono record evident (I) unauthorized disposal, (II) commercial advantage and (III) disposed by rental or any such other mean, considered as infringement (17 U.S.C. 109(B)(1)(A)). However, exemptions were granted for educational institutions 17 U.S.C. 109(B)(1)(B)(II) and non-profit libraries (17 U.S.C. 109(B)(2)(A)). Further, the computer program embodied in conjunction with limited purpose computer that is designed only for playing video games or such preliminary purposes are also exempted (17 U.S.C. 109(B)(1)(B)(I)). In 1992, European Union adopted a Rental Right and Lending Right Directive regulating the rental, lease or lending of all types of copyrighted works. The directive established exclusive right on copyright owners to authorize or prohibit rental of all works except buildings and works of applied arts (Council Directive 92/100 of 19 November 1992 O.J (L346)61). However, the right to control the rental of computer programs and regulations relating to further activities were prescribed under the E.C. software directive (E.C. Software Directive, article 4).

In comparison to the other forms of copyrighted works, it is unarguably accepted that computer programs need considerable protection due to the possibility to reproduce and the cost and difficulty involved in detecting and bringing legal action. However, here the industries relating to e-books, mobile applications, audio/video musical creations and even phonograms cannot be disregarded, as the works subject to the similar threat of piracy when available online. In this respect, wording of the TRIPS agreement is important which oblige particular members to consider evidence of widespread piracy before granting the exclusive rental rights under their respective copyright laws (TRIPS Agreement, Article 4). However, no international treaty still being able to prevent transboundary copyright violations that often takes place via the internet.

In this context, it is interesting whether the Internet Service Providers (ISP) are liable or not, for the violations conduct by their customers upon their internet systems (Fernando R, 2015, P8). Speaking very simply, ISP is the public or private entity (Sri Lanka Computer Crimes Act 2007, Section 38) who provides internet access to the subscribers (Religious Tech. CTR. V. Netcom On-line Communication Servs., INC907F. Supp. 1361).

They work as an intermediaries and facilitate senders and receivers to exchange their information. When the information transmitted from one place to another or publicly available, the ISP is involved. Since all the data transmissions exclusively deal with their involvement, arguably no violation could also be occurred without their representation. Therefore, one controversial proposal to mitigate unlawful distribution of copyrighted materials via the internet has been to hold ISP's liable for the copyright violations committed by their subscribers. Yan, offer plausible support for the aforesaid argument standing on three copyright doctrines. First, their ownership of the equipment that stores, makes and transmits copies of copyrighted material, their control of such ownership may be enough to make them directly liable as copyright infringers. Second, the relationship between an ISP and its customers may be close enough to make them vicariously liable.

Third, ISP might face contributory liability if they knowingly provide services to a subscriber who is committing copyright infringement (Yan A, 2000). The aforesaid three counts were logically applied at courts in various jurisdictions. Fin-reactor case in Finland (Manner, 2009) and Loki -Torrent and Elite-Torrent cases in United States (Enigmax, 2008) are traveling jurisprudence. Generally in all three aforesaid cases, defendants were ISP's and they were held guilty on facilitating for illegal file sharing, pre-commercial release work and ultimately for setting platform for the copyright infringement. In last December, in Pirate Bay case, while delivering rather strong judgement, Swedish court of appeal ordered ISP's (Bredbandsbolaget's) to block some of the file sharing web sites which give access to the pirating users (Sanches, 2017). However, reference to the Sri Lankan context, all three of the aforesaid arguments become invalid, hitherto the Electronic Transactions Act shield ISPs from any criminal or civil liability for the infringement committed by a third party through their operation systems (Sri Lanka Computer Crimes Act 2007, Section 16). However, Act setouts possibility for make contractual parties liable for the direct consequence of their mutual transactions and for the violations occurred to the third party, if those transactions attached the content held in copyright by another.

However, regarding the violations pertaining to the digitized works, those have become complex, volatile and hard even for specialists to understand completely (Palfrey J Et.Al, 2009). Sometimes those infringements occur because many internet users are ignorant of copyright



law (Palfrey J Et.Al, 2009, P5). Other users deliberately infringe and hope that they will be not discovered (Hartman J and Stubenrauch E 1999). Furthermore, the youth community which represents most of the digital consumers largely confused about whether it is lawful to upload, download, stream and remix the content. Student community believes that they have exclusive right to use copyrighted materials for educational purposes contrary to the rights of the other parties (McCullom K, 1999). In order to prevent such uncertainties, it is essential to rewrite the fair use doctrine by copying its requirements with the competing interests of the modern digital world (Abeysekera TB, 2013). In accordance with Palfrey et.al, presently fair use operates as a check on the monopoly powers that copyright holders would otherwise enjoy over their creative output (Palfrey J Et.Al, 2009, P6). This power is intended to enable the public to learn, criticize, parody and otherwise reuse copyrighted materials when the circumstances surrounding the use make it fair (Fisher W, 1988). However, when considering the entire emerging internet related copyright issues as a whole, it can be simply define as a disconnection between technological and the legal allowances, in combination with a lack of knowledge about copyright law in the general public. This resulted the environment which unpredictable for creators, unmanageable for innovators and impossible for citizens. Therefore, in order to prevent mounting confusions, the modern copyright law ought to be reformed, so as to promote the culture which protects creator, investor and the user as well.

### III. CONCLUSION

Present controversies involving copyright and digital technology open us a new opportunity for reassessment of how we apply the law for copyright infringements. Today, millions of users navigate the online milieu with varying degrees of ignorance and diverse range of misunderstandings about copyright law.

Apart from that, almost all kind of web based platforms impose relatively high barriers upon user's accessibility and those are passage to become copyright violations legitimize in the society. Furthermore, existing doctrinal approach to derivative rights create overlap in the "idea/expression" dichotomy and require new approach which has the ability to cope with evolving digital environmental conditions. Similar issues arise when applying the rental rights and related rights in respect of copyrighted works. However, law fails to provide justification for the additional protection provided to the computer programs

in comparison to other creative works. At the end of the day, liability of internet service providers in whole context is a problem unsolved.

### Recommendations

- Amend the Intellectual Property Act with new piece of legislation.  
Sri Lankan Intellectual property Act needs an amendment in order to face the evolving challenges in the digital era. The legislation must encompass new interpretations to the rights that come under the copyright law, and liabilities and exemptions of related parties for the prescribed activities.
- Promoting education instead of litigation is also recommended.  
It is essential to introduce copyright curriculum into the school and university system in order to promote awareness among student community about copyright violations. The process should be enhanced with audio tutorials, interactive activities, legal seminars etc.

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# CHALLENGES RELATING TO CROSS BORDER FLOWS OF DATA

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**Abstract** - Developments in technology are gradually changing the manner in which trade conducted throughout centuries. Trade of goods and services are gradually been replaced by trade of data across borders. Taking into consideration the value given for data today it can be considered the new oil in the 21st century. There are number of challenges when data is being transferred across borders. This includes protection of personal data and privacy, combating cybercrimes, protection of intellectual property. In addition, there is a great divergence between countries on free flow of cross border data. Some jurisdictions favour data protection and promotion of privacy over free flows of data whereas the others promote cross border flows of data for the promotion of international trade.

The objective of this paper is to identify the given challenges and to discuss the measures that have taken by the countries to overcome such challenges and to promote transfer of data. As the research Methodology are online study done on international treaties such as OECD Guidelines, EU Regulations on data protection, APEC framework, statutes and decided cases from other jurisdictions, published articles on cross border data transfers, privacy and data protection and the challenges relating thereto.

**Keywords** - Cross Border Data Flows, Privacy, Data Protection

## I. INTRODUCTION

Free flows of data across border has been identified as a market driving force in the 21st century. But there are number of limitation and restrictions which hamper such free flows of data. This paper identifies the given challenges relating to cross border data transfers and discuss the mitigatory measures taken by countries to reduce the impact of such restrictions.

Part 1 of this paper shall examine the manner in which flows of data is gradually replacing the traditional mode of international trade and the growing importance given to data today.

Part 2 will discuss the checks and balances placed by the governments to protect and promote privacy and data protection, prevention of computer crimes etc. which inadvertently impose limitations and restrictions on free flows of data.

Part 3 of the paper will discuss firstly the international and regional approaches towards promoting cross border data transfers followed by a discussion on national legislations.

Part 4 will discuss the mitigatory measures taken by jurisdictions to remedy the disparities and to reach a consensus when transferring data across borders.

Part 5 will provide the concluding remarks.

## II. PART I- DATA – THE NEW OIL

In the 21<sup>st</sup> century the traditional trade of goods and services is fast being replaced by flows of data across boundaries. Such data flows are enabled with the assistance of the developments in the internet and information technology (Meltzer 2014). Needless to state that in the past decade internet has changed all aspects of everyday life and today it has become a vital component of international trade.

Internet connectivity and increase in trade seems to go hand in hand as between 1996-2011 there had been a 10% increase in broadband penetration and this has raised annual 1.35% increase in GDP for developing countries and 1.19% in developed countries (IHRB, 2016).

Internet has introduced new modalities of conducting businesses. Electronic platforms such as Amazon, Alibaba, E-bay has made international trade accessible to everyone. Approximately 12% of global goods trade today is conducted via international e-commerce (McKinsey Report, 2016). For start-ups and SMEs the cost of conducting business has been greatly reduced by such developments. US ITC has estimated that the internet has reduced 26% of the trade costs on average (US ITC, 2014). In addition, internet has changed the manner in which traditional businesses are conducted across border. Today it is possible to maintain the company headquarters in one jurisdiction, manufacturing in another and to conduct business real time with marketing teams joining from different jurisdictions. According to research an estimate of 75% of the internet's benefit is being captured by companies in traditional industries (McKinsey Report, 2016). With digitalization is the new mode of globalization it has been estimated that in 2012, 61% of total US service exports and that 53% of the US imports were digitally delivered (Meltzer 2014).

With digitalization of trade, the new oil in the 21st century undoubtedly is data (<http://fortune.com/2016>). According to McKinsey Report (2016) cross border data flows now generate more economic value than traditional flows of traded goods. Therefore, with the growth of importance heavily weighting upon data, free flows of such data across boundaries becomes a crucial aspect for international trade.

Recent developments in related technologies have greatly assisted enterprises and government alike. Cloud computing, big data and internet of things (IOT) have been recognized as recent developments relating to information technology. Cloud computing has been defined by the National Institute of Standards and Technology as a pay per use model for enabling available, convenient, on-demand network access to a shared pool of configurable computer services such as networks, servers, storage, applications. Cloud computing is appealing to individuals and businesses alike for economic feasibility. It has been estimated that 59% of the global internet users will use cloud computing by 2020 (Cisco's Global Cloud Index, 2016).

Big data is the processing of large quantum of data by companies with special expertise to provide required results for enterprises and other institutions (Sivarajah, 2017). Big data provides enterprises with necessary business insights. It has been estimated that businesses

that have harnessed big data have seen a 60% operating margins in their businesses (McKinsey & Company, 2011).

IOT is the networking of devices, vehicles, buildings and other items to collect and exchange data (<https://www.exact.com>). Therefore, in addition to the computers and the smart phones to transfer data the new advances allow other appliances to engage in data collection and exchange which reflects the revolution that is taking shape in the near future. It is estimated that by 2020 there will be 26 Billion connected devices (<http://www.gartner.com>). With the world slowly moving towards smart cities and smart countries the question is how freely the data will be transferred across borders.

### III. PART II - CHALLENGES ON CROSS BORDER TRANSFER OF DATA

Although it is emphasized that free flows of cross border data should be allowed, there are number of restrictions and limitations in relation to free flows of cross border data. Some of them are listed as follows;

#### A. Privacy and data protection

By 2013, 99 countries have introduced some form of privacy and data protection laws that restrict the use of personal data (Greenleaf, 2013). Many countries have restricted the transfer of data cross border as they are concerned that the other countries may not have adequate protection for data. Setting up barriers to transfer data across borders is referred to as data localization (Ezell, 2013). For example, section 26 (1) of the Personal Data Protection Act 2012 (PPDA) of Singapore states that an organization must not transfer any personal data to a country or territory outside Singapore except in accordance with requirements prescribed under the Act to ensure that organizations provide a standard of protection to the personal data that was transferred so that it is compatible with the protection provided under the PPDA.

In addition, countries such Russia, China, Vietnam have legislations which insist that personal data of its citizens be kept on local servers. Needless to state that such localization measures by countries hamper cross border transfers of data.

## B. Cybercrimes

Initially the main concern on cybercrimes was relating to unauthorised access of personal information. But with the evolution of technology, increased connectivity magnified the cybercrimes and today they can take the form of copyright infringements, child phonography, global fraudulent financial schemes or cyber terrorism. (Clough, 2010)

Budapest Convention on Cyber Crimes has recognized following as computer related crimes. Illegal access, illegal interception, data and system interferences, misuse of devices, fraud and forgery using computers, child phonography and intellectual property rights violations. Many countries including Sri Lanka are party to the said convention and many have national legislations in place on cybercrimes.

Cybercrimes are a challenge to cross border transfer of data. Incidents such as computer related frauds create certain cautiousness among general public when their data is being processed in other countries. As a result, increase cybercrimes can hamper free flows of data across borders.

## C. Intellectual Property Rights

Although the internet provides hosts of opportunities, on the other hand it is deemed a nightmare for patrolling for intellectual property rights. Today where everything is available with a click of a button protection of copyrights, trademarks, patents, industrial designs and trade secrets have become a daunting task.

For example, issues such as BitTorrenting, where large files are being shared over peer to peer networks for the viewing of pirated movies and songs, is a growing concern. In the case filed against Artem Vaulin, the proprietor of Kickass Torrents it was alleged that his site was the 69th most visited site in the internet and had 50 Million unique visitors every month (<http://fortune.com/2016>). This will mean Millions of dollars in losses for genuine copyright holders. Therefore, many legislations are available today to combat such intellectual property related crimes.

## D. National Security

In the 21st century national security can be challenged by internet. It has been noted that data in relation to national security is being defined as important data. This is an effort to create a new data criteria and moving beyond

the traditional criteria of personal data and business data. Countries require an assessment of important data before them being transferred beyond borders. In the big data era many multinational companies have vast sources of data and any infringements in such data not only have an impact on personal information but also on national security as well (Hong, 2017). Therefore, in many data protection legislations, national security is being mentioned as an exceptional situation where data protections laws will not be applicable. But in relation to cross border transfer of data, data which have an implication on national security can be restricted by legislations.

## IV. PART III - OVERVIEW OF LAWS AND REGULATIONS RELATING TO TRANS-BORDER FLOWS OF DATA

### A. International Regulations

In recognizing the importance of cross border data flows there are number of initiatives taken by international and regional organizations.

What is noted is there is a divergence in the treatment of cross border data by two main international statutes on the subject namely the OECD Guidelines on the protection of privacy and trans-border flows of personal data (OECD Guidelines) which was introduced in 1980 and Convention for the protection of individuals with regard to automatic processing of personal data which was introduced by the Council of Europe in 1981 (Convention 108).

The OECD Guidelines highlight the importance of protecting personal data but at the same time has emphasized that restriction on data flows will hamper trade. In relation to cross border data transfers the following guidelines have been introduced by the OECD;

Article 15 – Member countries should take into consideration the implications for other Member countries of domestic processing and re-export of personal data.

Article 16 – Member countries should take all reasonable steps to ensure that trans-border flows of personal data are uninterrupted and secure.

Article 17 – A Member country should refrain from restricting trans-border flows of personal data between itself and another Member country except where the latter does not yet substantially observe the OECD Guidelines or where re-export of such data would circumvent its

domestic privacy legislations. A Member country may also impose restrictions in relation to certain categories of personal data for which specific regulations are available in the home country and when no equivalent protections are provided by the other Member country.

It is to be noted that many jurisdictions for example New Zealand Privacy Act 1993; UK Data Protection Act 1998; The South Africa Protection of Personal Information Act No. 4 of 2013 have used the principles set out by the OECD Guidelines.

On the other hand, Convention 108 is the first ever binding international instrument on protection of personal data and cross border data transfers (Unver, 2016). Article 12 (2) of the Convention states that “a Party shall not for the sole purpose of the protection of privacy, prohibit trans-border flows of personal data going to the territory of another party.” Article 12(3) provides the exemption for the general rule. i.e. when specific categories of personal data are being governed by special regulations such personal data shall not be transferred unless the other party does not provide adequate protection.

The European Union Regulation 2016/679 relating to the protection of natural persons with regard to the processing of personal data and on the free movement of such data is the latest Regulation in relation to cross border data transfers applicable to the European Union. According to Article 45 transfer of data to a third country or an international organization may take place when the European Commission decides that the particular country has “adequate” privacy protections. So far only 11 countries have been recognized outside the EU as having adequate protection (<http://ec.europa.eu/>).

Therefore, European Union being one of the biggest global traders have stricter regulations on personal data whereas the approach taken by USA is somewhat different and is recognized by EU as not having adequate data protection (NBT, 2014). As a result, the European Commission in 2000 approved EU-US Safe Harbour Framework as a special “adequate” protection mechanism. According to the said Framework US Companies can self-certify that they comply with the Safe Harbour principles and thereby qualify under EU regulations as “adequate.” But Safe Harbour principles were recently declared invalid by the European Court of Justice (Schrems vs. Data Protection Commissioner, C 362/14) and in 2016 this was replaced by the EU-US Privacy Shield.

The Asia-Pacific Economic Corporation (APEC) has introduced a Privacy Framework. APEC has introduced number of principles such as preventing harm, notice, collection limitation principle whereby it is expected that member countries to create their own privacy rules in consistent with the principles recognized.

But lack of consensus among the international treaties is a grave concern. When different countries and regions adopt different approaches for cross border data transfers this creates a negative impact on the transfer of data.

### **B. National**

As there is no model law available national approaches too vary on cross border data flows. Some countries have used the “omnibus approach” where they have introduced one overarching law that regulates data protection and cross border data flows e.g. South African Protection of Personal Information Act No. 4 of 2013 (POPI), EU data protection regulations.

On the other hand, countries such as India and the USA have used the “sectoral approach” where different sectors such as health are regulated separately (NBT, 2014). Quite contrary to these approaches some countries such as Sri Lanka do not contain any legislations at all.

## **V. PART IV – MIGRATORY MEASURES**

Since there is no global consensus on cross border transfers there are number of mitigatory steps taken by international organizations as well as countries to enable cross border transfers (Meltzer 2014);

1. Adequacy approach – Followed by the EU this assesses whether the other jurisdiction provides sufficient degree of protection for personal data in the event of a cross border transfer. For example, the Privacy Shield which was discussed above.
2. Binding Corporate Rules (BCR) – According to Article 47 of the EU Regulations, this is a set of internal rules adopted by a multinational company which defines their global policy on transfer of personal data within the group of companies but physically located at different countries. This internal standard has been recognized as a method which prevents data infringements in countries outside the EU and avoiding the need for a contract every time data is being transferred. (<http://>

ec.europa.eu). In EU BCRs needs to be approved by the data protection authority in each member state. Similar provisions are available on national legislations i.e. South Africa, POPI.

3. Model Contract Clauses (MCC) – Used by EU this approach allows a third party which uses a specific model words in their contract to provide adequate protection for the data that is being transferred. EU has developed two types of standard clauses which govern both data controller to data controller and data controller to data processor relationship. MCCs are more popular but on the other hand this may be cumbersome for multinational companies as they need to have data processing agreements in place with each and every entity with whom they will be exchanging data. (Bloom and Royal, 2015)
4. Consent – Many countries would require the consent of the data subject for the transfer of personal data to another jurisdiction. In Belgium according to Law on the protection of privacy in relation to the processing of personal data, transfer of personal data to countries which have not been recognized as providing adequate protection is in principle prohibited (Article 21). But there are certain exemptions and one such exemptions is that the data subject has given his unambiguous consent to the proposed transfer (Article 22).
5. Contracting purposes – Personal data transfer is allowed in an instance where performance of a contract between the data subject and a third party.

## V. PART IV - CONCLUSION

What is to be noted is that although it is evident that free flows of data promote trade and is beneficial for individuals and for companies alike but lack of consensus between the legal approaches seems to create issues.

What is noteworthy is that there is no model law for the governess of cross border transfer of data. Many legislations have opted for the EU based laws relating to data protectionism thereby restricting flows of data and on the other hand some countries have opted for sectoral approach by bringing in different laws to govern different sectors. All in all, this has an implication on businesses as they will have to comply with different sets of legislations in each jurisdiction that they conduct business. On the other hand, some countries such as Sri Lanka do not have

specific legislations on data protection and cross border data flows. This approach will definitely isolate the country whereby other countries will not transfer data to countries such as Sri Lanka for processing as they do not provide the adequate safeguards that is required. Therefore, when trying to rely on knowledge economy such lacunas in the domestic laws should be remedied if the country is to reap benefits from the new digitalized world economy.

So what is required today is a Model law which strikes a balance between the privacy of individuals and data protection at the same time which promotes international trade.

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# RECONCILING BREEDER'S RIGHTS AND FARMER'S RIGHTS FOR FOOD SECURITY IN SRI LANKAN CONTEXT: A COMPARISON WITH INDIA

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**Abstract** - Sri Lanka owns a noticeable history of agricultural sector that has been flourishing since ancient times, where food security had been ensured for decades. The advancement of technology unwrapped new capacities in science which enabled new plant varieties to play a key role in agriculture, which diminished the traditional knowledge of farmers. Sri Lanka as a developing state has ratified International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), which has granted recognition for farmer's rights while Sri Lanka has not been able to ratify International Convention for the Protection of New Varieties of Plants (UPOV) that has prioritized breeder's rights. However, the significance of creating new plant varieties should be addressed in the domain of food security of the world and likewise in a context where sustainable development goal has set to end hunger, achieve food security and improve nutrition and promote sustainable agriculture. Yet Sri Lanka has failed to introduce any legislation where states such as India has been able to enact proper mechanisms to reconcile the rights of both breeders and farmers without even joining the UPOV convention. Thus, the objectives will concentrate on methods where these rights can be settled, examine the international legal regime, examine loophole in Sri Lankan system and to make the second goal of sustainable development goals a reality. The information regarding this will be derived from primary sources; conventions, legislations of Sri Lanka and India. Qualitative data will be gathered through books and journals while interviews will be also incorporated. Discussion comprise mainly an analysis and have emphasized on the conflicting interest of rights of breeders and farmers. Finally, this paper will encourage to generate recommendation for the existing loopholes while proposing a unique legislation for Sri

Lanka in order to reconcile breeder's rights and farmer's rights.

**Keywords** - Breeder's rights, Farmer's rights, Sri Lanka, food security

## I. INTRODUCTION

Since the origination of mankind human beings tend to find ways in which they could end their hunger where they hunted for food until they discovered agriculture that a way of growing plants to end their starvation. The relationship between human and agriculture is always together since humans relied upon food. Different eras have proven that agricultural methods became more progressive day by day. The technological advancements have altered the methods of traditional agriculture and have widen the scope of food industry through the intervention of biotechnology, where traditional knowledge of farmers have been less recognized. Thus, it is observed that existing farmers who utilize traditional knowledge are in conflict with the group of persons who are developing new crops for the agricultural sector. However, in a global context where food security is been debated new methods within agricultural sector, new crops that provide rich harvest has already become a necessity, which has highlighted the importance of biotechnology. A breeder is someone who produce a novel plant variety for a farmer to grow on farmer's field, which utilizes science and technology for advancing an existing plant variety. On the other hand farmers utilizes traditional knowledge to develop and maintain a particular plant variety. Both these parties engage in developing plant varieties that attract intellectual property rights protection while securing the right to food

as a basic human right. However, the conflict between breeder's rights and farmer's right still remain due to the conflict of interests of developed and developing states. Developed states usually desire more towards breeder's rights while developing states comply with farmer's rights within the scope of plant variety protection, which shall be reconciled for achieving food security in future especially in least developed states.

#### A) Relevancy of the topic

The essence of this topic relates to food industry where right to food has been recognized in many international platforms. Lack of food leads to various types of abnormal health conditions for humans, thus food is concerned as an essential in our daily lives. Universal Declaration of Human Rights (UDHR, 1948) is the foremost documents which has recognized the importance of adequate food under Article 26 which stipulates "Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food..." moreover, the international covenant of economic, social and cultural rights (ICESCR, 1966) elaborates broadly on right to food under its article 11, which also recognizes adequate food for individual and for his family while emphasizing government's commitments recognizing the fundamental right of everyone to be free from hunger through individual and international corporation (Article 11 (2), ICESCR). Further, subsection 2(a) of Article 11 discuss about improving methods of production which demonstrate the full use of technology and scientific knowledge, that denotes indirectly regarding breeder's commitments. Apart from the right that has recognized food security, global community has also debated on the same topic under sustainable development goals (SDGs) which came into effect on 1st of January 2016. Thus, the relevancy of this topic strictly speaks how it is important to the changing global environment. The second SDG focusses on eliminating hunger, achieve food security and improved nutrition, and promote sustainable agriculture which demonstrate how each state should adhere according to the current needs and how breeders and farmers should cooperate each other in order to make this goal a reality and to supply of nutritious food in the aspect of growing populations. Several international conventions have discussed on this global issue and have made member states obliged towards them, which will be examined under this research paper. Moreover, Sri Lanka was selected as a developing state which still depends on agriculture and Indian jurisdiction was selected as a state which possess similar cultural, social, economic and political background for the purpose of comparing.

#### B) Research Problem

Whether Sri Lanka is effectively implementing international obligations and what are the loophole in plant variety protection system in Sri Lanka and why it has not signed the Convention for the Protection of New Varieties of Plants (UPOV).

#### C) Research Objectives

The research will be directed towards achieving the second goal of SDGs; "End hunger, achieve food security and improve nutrition and promote sustainable agriculture." Further it will focus onto make authorities realize the current political culture that have developed with sustainable development in order to create necessary legislation that will reconcile rights of breeder and farmer which is unique to Sri Lankan context.

## II. METHODOLOGY

The study adopts an empirical research methodology which uses both qualitative approach using materials include conventions and legislation as primary sources and books, electronic/ internet sources, journal articles as secondary sources while quantitative approach will be used through interviews of expertise persons and small group discussions in order examine the practical defects of the current system in Sri Lanka and to seek the public awareness about his subject. The author will use the international and comparative research methodology since it has selected a jurisdiction (India) for comparative purposes.

## III. DISCUSSION

Holding to the objective of food security, plant variety protection debates about two groups; breeders and farmers. Both these groups deal their work with plant genetic resources which are essential for improving plant varieties. On this point it is worth to note that new varieties attract intellectual property rights (Helfer 2004, p. 03), which has become the reason why some international communities have prioritized breeders to preserve what they have created to attract financial gains/investments. On the other hand, farmers use their traditional knowledge of securing plant varieties that they have developed using basic procedures of their own. However, protecting both these parties is essential for the purpose of food security as well as for gaining economic benefits. The international and national commitments will be discussed as follows;

## A. International Regimes

1) International Convention for the Protection of New Varieties of Plants (UPOV Convention): The international union for the protection of new varieties of plants (UPOV) is an intergovernmental organization based in Geneva, which was established in 1961 by the international convention for the protection of new varieties of plants. Plant variety protection under UPOV convention is a sui generis form of intellectual property protection (Jordens 2005, p. 239) that encouraged the expansion of new varieties of plants, for the benefit of humanity. It made state members bound to grant and protect breeder's rights under Article 2 of its convention, which demonstrates the priority of the convention. A breeder is defined as a person who bred, or discovered and developed, a variety, a person who is the employer of the aforementioned person or who has commissioned the latter's work, where the laws of the relevant contracting party so provide, or a successor in title of the first or second aforementioned person according to Article 1 of the convention. Article 5 specifies the criteria of granting a breeder of its rights which states that plant variety that was developed need to be new, distinct, uniform, and stable. Furthermore, the convention discusses about duration that is being granted for a protected breeder under its Article 19 (2); "said period shall not be shorter than 20 years from the date of the grant of the breeder's right. For trees and vines, the said period shall not be shorter than 25 years from the said date".

The scope of rights can be categorized as follows; production or reproduction, conditioning for the purpose of propagation, offering for sale, selling or other marketing, exporting, importing, and stocking, which seems a wide array of rights (Article 14, UPOV). On this occasion it should be noted that contracting parties for this convention can be either states or any intergovernmental organization. Breeders sometimes are employed in private research institutes despite serving on government sector which is crucial at this point since developed states usually invest more share on research and development which is aimed for earning. Suppose that a breeder obtain a sui generis protection for a plant variety, then a commercial farmer will have to obtain authorisation from the breeder to grow them. However, few exceptions can be found under Article 15 which illustrates that "each contracting party may, within reasonable limits and subject to the safeguarding of the legitimate interests of the breeder,

restrict the breeder's right in relation to any variety in order to permit farmers to use for propagating purposes, on their own holdings, the product of the harvest which they have obtained by planting, on their own holdings, the protected variety or a variety as covered by Article 14(5)(a)(i) or Article 14(5)(a)(ii)". Yet, it is significant to understand that the main objective of this convention is to protect breeder's rights rather than of farmer's. Moreover, UPOV operates with a strict revision system, where a state that wants to become a member, it must get its national implementation Act approved by the UPOV before becoming accepted as a member (Article 34(1)). These conditions are rather unfavourable for developing states that depends on traditional and inherent knowledge of their farmers (The UPOV Convention, Farmers' Rights and Human Rights 2015, p. 47). Thus, it shall be noted that granting breeder's rights may not earn the best for the developing state in present global context where multinational corporations (MNCs) play a major role in global affairs and even in food industry. Therefore, recognition of farmer's contribution is equally important.

2) Agreement on trade-related aspects of intellectual property rights (TRIPS): It is an agreement that came into force as an additional protection mechanism for intellectual property rights in relation to trade and investments. It has also recognized plant variety protection under its Article 27(3) (b) which states that "...However, Members shall provide for the protection of plant varieties either by patents or by an effective sui generis system or by any combination thereof." It impliedly highlights regarding the tradability of these plant varieties which can hinder the domain of traditional knowledge of farmers, which can be contrary to farmer's rights and also will grant the breeder exclusive right to prevent third parties from selling, making, importing or using his or her product (Plant variety) (Article 28, TRIPS). However, the term breeder has not been defined under this agreement and one could argue that even a farmer may come within the purview of this Article, where there will be no conflict of interest between two groups (breeders and farmers). Additionally this document takes a liberal approach in implementation giving sufficient authority for states to make necessary national legislation for make prescribed standards a reality (Article 1, TRIPS). Thus, this international document also demonstrates the significance of plant variety protection for ensuring food security.

3) International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA): The international treaty on plant genetic resources on food and agriculture was adopted on 3rd November 2001 by the support of world food and agriculture organization (FAO), after seven years of negotiations. This legally binding treaty covers all plant genetic resources relevant to food and agriculture. The objectives of this treaty are the conservation and sustainable use of plant genetic resources for food and agriculture and the fair equitable sharing of the benefits arising out of their use, in harmony with the Convention on Biological Diversity (CBD), for sustainable agriculture and food security (Article 1, ITPGRFA). This convention focuses on issues not covered by the CBD or any other convention such as farmers' right (Hossam, James, & Grace, p. 24-25).

The scope is being discussed under Article 3 of the convention which states that "This Treaty relates to plant genetic resources for food and agriculture." It indicates that this treaty also concern about plant varieties that are utilized for ensuring food security. The treaty does not confer power upon breeders rather it has empowered traditional knowledge through recognizing farmer's rights in the scope of plant generic resource management.

The concept of farmers' rights were developed in order to counterbalance the intellectual property system, and to ensure that barriers were not created against the farmer's use and development of plant genetic resources. Article 9 elaborates about farmer's rights specifying that; "the contracting parties agree that the responsibility for realizing farmers' rights, as they relate to plant genetic resources for food and agriculture, rests with national governments. in accordance with their needs and priorities, each contracting party should, as appropriate, and subject to its national legislation, take measures to protect and promote farmers' rights, including, protection of traditional knowledge relevant to plant genetic resources for food and agriculture, the right to equitably participate in sharing benefits arising from the utilization of plant genetic resources for food and agriculture, and the right to participate in making decisions, at the national level, on matters related to the conservation and sustainable use of plant genetic resources for food and agriculture (Article 9.2, ITPGRFA)."

Unlike the UPOV convention ITPGRFA does not devalue sovereignty values as per said in Article 10.1; "Contracting parties recognize the sovereign rights of States over their

own plant genetic resources for food and agriculture, including that the authority to determine access to those resources rests with national governments and is subject to national legislation."

And the convention act as a coordinating party which strengthens the relationship among states through a multilateral system of sharing resources, information and even supporting each other at crucial conditions as per said under Article 12.6; "In emergency disaster situations, the contracting parties agree to provide facilitated access to appropriate plant genetic resources for food and agriculture in the Multilateral System for the purpose of contributing to the re-establishment of agricultural systems, in cooperation with disaster relief co-ordinators." Thus, this convention move forward with a sustainable fashion attracting both developed as well as developing states. It seems moral to uphold the recognition of traditional knowledge, since there are parts of the world that still depend on basic agricultural methods and who are vulnerable against colossal multinational corporations. Further, it shall be noted that Sri Lankan as a developing state has become a member of this treaty, yet Sri Lankan has not come up with any specific legislation, which is seen as a deficiency in plant variety protection system.

## B. Indian Jurisdiction

As one of the most powerful states in the South Asian region India consist with an agricultural based economy. Considering about plant variety protection and food security in the Indian context it has contributed itself with an unique system of protection which is a sui generis protection provided through a particular legislation which is known as the "The protection of plant varieties and farmers' rights Act, 2001" since it excluded agriculture from its patent Act of 1970 (Sastry. 2003-04, p13). Although it has not joined to UPOV convention it has made some valuable effort in recognising breeder's rights through this Act while securing farmer's rights as well.

The rights of breeder's are protected under section 28 (1) of the Act which mentions that "Subject to the other provisions of this Act, a certificate of registration for a variety issued under this Act shall confer an exclusive right on the breeder or his successor, his agent or licensee, to produce, sell, market, distribute, import or export the variety". It allows a breeder to authorize any other person to produce, sell, market or even export the protected variety. Moreover, looking into farmer's rights, it has been elaborated under sixth chapter and the section 39 (1) (i)

emphasizes that “a farmer who has bred or developed a new variety shall be entitled for registration and other protection in like manner as a breeder of a variety under this Act”. What is fascinating about this legislation is that it has also established a specific tribunal (Plant varieties protection appellate tribunal) to exercise jurisdiction of the authority established by this Act under section 54, while introducing offences, penalties and procedures for remedies in breach of any rights stipulated in this Act (Government of India 2001, s. 64). Thus, it seems that India’s legislation comprise a strong complex mechanism for reconciling the rights of breeder and farmer. It demonstrate the intention of the Central government and even of the legislation of ensuring food security within their territorial limits.

### C) Sri Lankan Jurisdiction

Sri Lanka was known as the “granary in the East” as Sri Lanka was able to even export food for other countries. From the ancient times Sri Lanka has been an agricultural country that fulfilled its food requirements locally. At present 65% of the total land area of the country have been used for agriculture, 40 % for paddy, 38% for plantation crops and 22% for other crops. More than 70% of the country’s population are living in rural areas whose main livelihood being agriculture (Food production national programme 2015, p. 51). Biodiversity regarding agriculture is so vast and Sri Lanka is home for many endemic species of plants and animals. However, in present day scenario Sri Lanka has become a food importer according to statistics (approximately Rs. 100 million annually) and food security has become a serious factor for economic conditions as well. Thus, strengthening farmers as well as the domain of new plant varieties are significant at the moment.

Considering on food security, plant variety protection is the major area of this research that focuses on protecting genetic resources of a particular variety that connects two stakeholders; breeders and farmers. It shall be noted that while Sri Lanka has not been a party to UPOV convention, it has acceded to the ITPGRFA in 17th September 2013. Thus, Sri Lanka is a contracting party which commit themselves for the treaty obligations, and for an international obligation to become binding in a country, the legislation of that state must incorporate the obligations into the domestic legal domain. Furthermore, even though Sri Lanka consented to TRIPS, the local legislation which is the Intellectual Property Act No 36 of 2003 excluded plant variety protection that was admissible

under TRIPS (Article 62(3)(b), Intellectual Property Act No 36 of 2003). Apart from this legislation it was revealed that Sri Lanka had made two attempts to draft document regarding plant variety protection. The drafted document of 2001 (Protection of New Plant Varieties (Breeder’s Rights) Sri Lanka 2001) was failed due to grant of priority for breeders (it consisted with provision that were included in the UPOV convention) while the second attempt was developed in 2011, which is seen as a comprehensive document that recognized both breeders and farmers rights. The document was titled as “Protection of New Plant Varieties Act” (Kamardeen 2013, p. 52).

### D) Analysis

The author does not intend to describe specific provision of the drafted documents in the Sri Lankan legal system, since it has broadly discussed under previous researches (Harankaha H, p. 163) (Wijesooriya (as cited in Kamardeen, 2013)). Therefore, the author will intend to elaborate on the social implication of enacting such law and what needed to be done in order to generate an effective plant variety protection mechanism. It was found during the research that plant variety developments are done specifically by government funded institutes such as Sri Lankan tea research institute, industrial technological institute etc. while there are few private parties such as Hayleys and CIC etc. who are devoted for plant improvements through technical methods. Both these public and private sectors develop plant varieties and disseminate them for farming which is the usual procedure that was in existence for years in Sri Lankan context. However, it shall be understood that these efforts are not sufficient for a country which is having a growing population and local private sector should be empowered to play a main role while having strong regulations to monitor their practices for the interest of the country.

A protection mechanism regarding plant variety is significant as development of a plant will come as a result of a long term research techniques with money as well. It was found that state funding for plant variety development is not in satisfying levels and the absence of a protection mechanism for breeder has caused unwillingness for investment in plant breeding domain, since a breeder might lose the ability to gain profits out of its effort (creations of one’s mind), which indeed the particular plant variety will be used for commercial purposes by others (for selling and reproduction). In another perspective, it can be

argued that use of biotechnology might make traditionally developed plant varieties (and knowledge used for such creations) vulnerable hence it could be misappropriated by others especially through biopiracy. "Biopiracy, refers to the appropriation of the knowledge and genetic resources of farming and indigenous communities by individuals or institutions that seek exclusive monopoly control (patents or intellectual property) over these resources and knowledge" < [www.etcgroup.org/issues/patents-biopiracy](http://www.etcgroup.org/issues/patents-biopiracy)>. In Sri Lanka there are no adequate law to protect the biopiracy (Galhena 1995, p. 23). Therefore, if someone could export a valuable plant variety to another country or if someone offer it to a private party, then if that party obtains the patent protection from another jurisdiction, a country that inherited the plant might have to pay compensation for using such variety for the party who had obtained the patent, which is not a worthy situation for Sri Lanka which is rich with biodiversity.

Thus, generating a system that recognize breeder's rights while having strong mechanism to combat against biopiracy issues is significant in a country like Sri Lanka because once a developed variety is granted protection through either patent or a sui generis system it will earn for itself when someone else uses it. On the other hand, protecting agricultural bio diversity of Sri Lanka and the rights of the farmers are also equally important. As the case demonstrates most of the rural population rely on agriculture.

Farmers rely on government funds and they usually rely on loans to buy seeds as well as fertilizers and other elements for agriculture. Despite hardships, they contribute massively for food security in Sri Lanka, therefore, it is not ethical if the legislature do not recognize their rights. From ancient times farmers have carried down special varieties that are resilient for Sri Lankan context (climate conditions), which need to be protected within the scope of farmer's rights. The problems within farmers community is also a crucial problem apart from the domain of plant variety protection.

It was found through interviews that the plants were excluded from the intellectual property Act no 36 of 2003, since the authorities were intending to propose a new law for plant variety protection, which never came into force even sustainable development goals were recognized in Sri Lanka. Further, it was clarified that there is lack of political will and the lack of awareness and knowledge among farmers too, which have lessen the importance of such legal piece. Considering about the international

treaties UPOV convention strongly recommend breeder's rights which is unfavourable for a developing state like Sri Lanka. On the other hand, Sri Lanka became a member of ITPGRFA in 2013 where they recognized farmer's rights globally. Moreover, Sri Lanka as a member of the world food and agriculture organization (FAO), which govern the ITPGRFA, Sri Lanka obliges to send national report regarding the implementation activities (in accordance with the Article 21 of ITPGRFA which discuss about compliance procedures). Looking into the TRIPS agreement it has allowed states to adopt unique systems for plant variety protection and the ideal example that can be found is through the selected Indian Jurisdiction which have broadly reconciled rights of breeders and farmers, which can be even acceptable for Sri Lankan context.

## IV. RECOMMENDATIONS AND CONCLUSION

The research has broadly discussed about the international legal regime as well as the Sri Lankan jurisdiction along with the Indian Act for comparative purposes. It shall be stated that all these mechanisms are created for ensuring food security of the whole community. It was unveiled that UPOV convention is taking some steps for granting breeder's rights while ITPGRFA has recognized farmer's rights and acts as a balance legal document. However, both these document have their own issues (while UPOV prioritize breeder's rights ITPGRFA does not state regarding an implementation process of farmer's rights in its document). Thus, an unique legislation is proposed for Sri Lanka.

The Indian Act is a good example and it has compressively created a mechanism even for settlement of disputes. Thus, it is recommended to learn lessons from the neighbouring state. National food production programme of Sri Lanka (2016-2018, Pg.51) had already commenced and it has recognized the plant protection Act which was proposed in 2011. However, it has not specified on the method that the authorities will implement such programme within two years. It is satisfying of the recognition but is shall be noted that a legislation will not totally eliminate the social issues. Therefore, continued awareness should be given for farmers as well as breeders. If the community is unaware of their rights that would not properly give effect for the provisions. Thus, it is recommended/ proposed to use National food production programme of Sri Lanka as a platform in disseminating awareness and both private and public parties should be gathered in order to ensure food security since it a collective effort.

Sustainable development goals emphasizes on food security and such targets mentioned under the second SDG shall be incorporated into the national implementation process, which will attract International Corporation as well. Plant variety protection was debated for a long period and a proper outcome is a necessity where political will shall be generated within the legislature and from outside the legislature by both breeders and farmers.

This will ensure food security as well as a basic human right. Thus, reconciling Breeder's rights and Farmer's rights for food security in Sri Lankan context is at utmost important stage.

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# TURN TO YOUR DUTIES TO RETAIN YOUR RIGHTS: CRITICAL ANALYSIS ON RIGHT TO WATER

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**Abstract** - The outstanding importance of water has pronounced many of scholars in various occasions. Water is necessary for the survival of entire life, yet over one billion people do not have available sources of clean water for drinking. People those who are undergoing water scarcity menace tend to claim right to water from governments without considering their obligations to uphold the right. However this situation should be observed in reciprocal manner. Right to water is entirely based on the availability of the resource. Without prejudice entire mankind is responsible altogether to safeguard water resources. Presently water is facing for a huge threat of pollution and over extraction which was created and responsible by the mankind themselves and the mankind rapidly reaching towards an era of the water scarcity. Immerging trend to expand the Right to Life which has been recognized by the Article 3 of the UDHR accommodated the Right to Water by establishing state obligations through several other instruments such as Treaties and their Protocols, Regional instruments and International declarations, norms and other standards. Hereby all the states are compelled to provide continuous water supply and to facilitate various other integrated water resource management systems in order to enhance the infrastructure facilities to uphold water rights. Hence it is essential to turn towards the duties and responsibilities of the people being right holders to become eligible to claim their rights from governments being duty bearers. This paper expects to investigate the possibility to assign duties upon general public to safeguard water resources mutually as to preserve their right to water. The main objective of this paper to convince the contribution of the community

to counter future challenges of fresh water and indicate the necessity of contribution to preserve fresh water resources. Further this research expects to emphasize the necessity of reciprocal approach to claim water rights and to elaborate the mutual understanding between right holders and duty bearers in terms of water rights.

**Keywords** - Right, Water, Reciprocal Obligation, Duties

## I. INTRODUCTION

Uttering the importance of water as an inheritance of humankind, few centuries back Chief Seattle pronounced that “This shining water that moves in streams and rivers is not just water but the blood of our ancestors.”<sup>1</sup> It demonstrates that human beings are part and parcel of the nature and water is the nexus between the nature and mankind. The famous adage made by King Parakramabahu (1153 – 1186) “not even a little water that comes from the rain must flow into the ocean without being made useful to man” further annunciate the great effort made by our ancestors to utilize water in ancient times.<sup>2</sup>

Even though people being right holders claim their rights from states being duty bearers under rights based approach, states are incapable to facilitate alone without support of the general public. It is unreasonable to claim such rights in a one way channel. People those who claim right to water need to accomplish their reciprocal duty towards sustainability of water while they demand continuous water supply.

<sup>1</sup> < <http://www.snopes.com/quotes/seattle.asp>> Last visited 01.03.2017

<sup>2</sup> Culavamsa, LXVIII, 8

Reciprocal approach of right to water is not a direct liability which can be imposed on each and every human being by way of a compensative manner. People should be empowered with legal backing to act against water polluters and over extractors in order to preserve water resources. Protection of water resources is a universal obligation that has been posed before water scarcity. It is a prime duty of mankind to ensure the sustainability of water resources in order to ensure the life on earth.

This study mainly focused on the reciprocal affiliation between rights and duties with regard right to water. International community has recognized water as a human right. Sometimes entire mankind is liable to accomplish certain duties towards the sustainability of water resources.

Accordingly it is clear that people are having a reciprocal duty to preserve water resources being right holders of right to water. Otherwise water resources will not remain to uphold the right to water. However most of the people do not aware of their obligations and reluctant to perform their duties to preserve water resources. Thus this research intend to investigate the problem that “why people neglect to uphold their duty to preserve water resources which would conserve the water supply despite the states endeavour to ensure the right to water of people themselves?”

Primary objective of this research is to educate the community in relation to future challenges of fresh water and necessity to preserve fresh water resources. Further this research expects to emphasize the validity of reciprocal approach to uphold the right to water and requirement to establish mutual understanding between right holders and duty bearers.

## II. RIGHT TO WATER AS A HUMAN RIGHT IN INTERNATIONAL PERSPECTIVE

Apparently our planet is full of water recourses and id the secret of life. Even though 70% of our planet is covered by water; 0.007% is limited for human consumption and over one billion people do not have available sources of clean water for drinking.<sup>3</sup> In order to overcome this tragic situation United Nations World Water Development Report has given top priority to implement sustainable strategies to preserve water resources for future

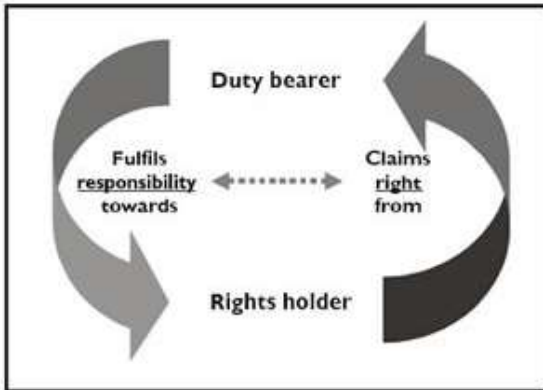
generations.<sup>4</sup> In 2002 the UN Commission on Economic, Social and Cultural Rights defined the right to water as “right of everyone to sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic uses”. In 2008, the UN Council of Human Rights decided to establish an independent expert on the issue of human rights obligations related to access to safe drinking water and sanitation. In 2010, the General Assembly acknowledged the “right to water” and the Human Rights Council adopted a binding resolution affirming that the human right to safe drinking water and sanitation are a part of the right to an adequate standard of living and inextricably related to the highest attainable standard of health.

Human rights are protected by internationally guaranteed standards that ensure the fundamental freedoms and dignity of individuals and communities. They include civil, cultural, economic, political and social rights. Human rights principally concern the relationship between the individual and the State. Governmental obligations with regard to human rights can broadly be categorized in obligations to respect, protect and fulfil.

Although the government would agree to accomplish the responsibility cast upon them certain unavoidable circumstances may interrupt the continuous water supply. However always people being right holders should be responsible to protect, maintain and sustain available water resources to uphold the right to water by the state.

It has been decided by the global community to recognize water as a human right before many challengers confront. The General Comment No. 15 of the UN committee on Economic, Social and Cultural Rights (CESCR) set out the right to water as the right of everyone in 2002 “to sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic uses”.<sup>5</sup>

Nevertheless people around the globe confront significant difficulties in access to water; do not focus on immerging challengers of preserving water resources. On the other hand it is essential to safeguarding water recourses rather than claiming to preserve right to water as a human right. Indeed, the right to water is one of the constitutional guarantees which find many obstacles for its effectiveness both in developing and developed countries.<sup>6</sup> Taking into account all these circumstances, the justifiability of the right to water or, in other words, the effective access of citizens to safe water and sanitation is crucial.<sup>7</sup>



It is important to inquire the transnational environmental law perspective in right to water as a human right and identify key controversial issues involved in the recognition of the right. Right to water accrued the due recognition as a human right very recently.<sup>8</sup> UN convened the First World Conference on Water in 1977 and subsequently launched the International Decade of drinking water and sanitation 1981-1990 in order to ensure equitable and safe access to water resources.<sup>9</sup>

States are obliged to actively involve with human rights to respect, protect and fulfil. Even though International Covenant on Civil and Political Rights (ICCPR) does not expressly recognize the right to water,<sup>10</sup> some other human rights treaties explicitly recognize the right to water. In this regard, the Convention on the Elimination of All Forms of Discrimination against Women (CEDAW) provides in Article 14 paragraph 2 (h) that States Parties shall ensure to women the right to “enjoy adequate living

conditions, particularly in relation to... water supply”.<sup>11</sup> Furthermore, the Convention on the Rights of the Child in paragraph 2 (c) of Article 24 requires States parties to combat diseases and malnutrition “through the provision of adequate nutritious foods and clean drinking- water”.<sup>12</sup> Similarly, the Convention on the Rights of Persons with Disabilities in Article 28.2.a sets out the obligation of States to “ensure equal access for people with disabilities to clean water services”.<sup>13</sup>

However these international human rights instruments provided a legal basis for the right to water arises from human rights and guarantees as enshrined in national constitutions. Thus the right to water has been recognized directly or indirectly in different national constitutions, among them, for instance, the constitutions of South Africa, Ethiopia, Kenya, Bolivia, Ecuador and Uruguay encompass the right to water, whereas the constitutions of Gambia, India, Venezuela, Spain and Belgium provide for an indirect recognition.

While establishing right to water the Constitution of South Africa embedded very special and advanced provision as to the obligation of natural and legal persons to respect the right to water. The right provided by the constitution would raise reciprocal duty for both parties to preserve natural resources by Article 24 (b). It highlights the requirement of conserving natural resources through reasonable legislative and other measures for the betterment of present and future generations. In this regard other measures would be included with reciprocal and mutual participation of general public to preserve natural resources while the state arranges infrastructure facilities. South African constitution further expands this

<sup>3</sup> World Health Organization , The Right to water , P12(2003)(Life Liberty, and the Pursuit of Water: Evaluating Water as a Human Right and the Duties and Obligations it Creates; Amy Hardberger)

<sup>4</sup> The United Nations Water Development Report

<sup>5</sup> General Comment No. 15 (2002), Economic and Social Council, 20.01.2003, E/C.12/ 2002/11. <[http://www2.ohchr.org/english/issues/water/docs/CESCR\\_GC\\_15.pdf](http://www2.ohchr.org/english/issues/water/docs/CESCR_GC_15.pdf) > Last visited on 04.04.2017

<sup>6</sup> General Comment No. 15 (2002), Economic and Social Council, 20.01.2003, E/C.12/ 2002/11. Page 2 . <[http://www2.ohchr.org/english/issues/water/docs/CESCR\\_GC\\_15.pdf](http://www2.ohchr.org/english/issues/water/docs/CESCR_GC_15.pdf) > Last visited on 04.04.2017

<sup>7</sup> Chapple, Ellen& Leitch, Frances, “The Right to Water: Does it Exist and is it Justifiable Content?”, available at <http://law.anu.edu.au/coast/events/environment/papers/chapple&leitch.pdf>. “What price for the priceless?: Implementing the justifiability of the right to water”, 120 Harv. L. Rev. 1067 (2007), <<http://www.sciencedirect.com/science/article/pii/S1870465415000100>> Last visited 05.04.2017

<sup>8</sup> A. Boyle, “Human Rights and the Environment: A Reassessment - First Preparatory Meeting of the World Congress on Justice, Governance and Law for Environmental Sustainability”, <[http://www.unep.org/dec/worldcongress/docs/Towards the declaration human rights.pdf](http://www.unep.org/dec/worldcongress/docs/Towards%20the%20declaration%20humanrights.pdf)> Last visited on 12.04.2017

<sup>9</sup> Attila, T. and Arcari, M., The UN Convention on the Law of International Watercourses, The Hague, Kluwer, 2001

obligation by interpreting right holders as to natural and legal persons. Apart from that in India, several courts have endorsed the right to water in the broader context of right to life recognized in Article 21 of the Constitution of India.

### III. HISTORICAL BACKGROUND OF WATER RIGHTS AND EFFECTIVENESS OF PARTICIPATORY MANAGEMENT SYSTEM

Water was highly preserved and carefully managed by the ancient community of Sri Lanka as a scarce resource which would immensely used for rice cultivation. Most of the ancient kings deemed to facilitate rice cultivation by providing appropriate infrastructure facilities to assure sufficient water supply. Colossal kingships were turned up by constructing massive tanks throughout the history and people tend to believe that they protect tanks even after their demise by becoming gods. For an instance King Mahasen who ruled the country from 277 to 304 AD is being worship by the people as a god Mahasen. A range of disciplines and practices related to water developed over the years have been established as customary laws in various regions of the country. Sometimes certain cultural values were influenced to amplify customary laws. It would accommodate equitable sharing during the stressed times and all the community were bound to preserve water resources and water management system. Irrigation system and advanced management procedures

affiliate with irrigation process in the ancient Sri Lanka were based on the sense of moderate cautiousness with a mix of paternalism, humanitarianism, and self interest. Correlative practices of the ancient institutions of compulsory labour (Rajakariya) and hereditary tread man ship were supported to persistence of the irrigation system. However it was abolished by the Colebrooke-Cameron reforms of 1832 and Paddy Lands Irrigation Ordinance No. 9 of 1856 was enacted for the purpose of resuscitate the ancient customs, traditions, and practices in the paddy sector. The preamble to the Ordinance specifically pronounced the validity of ancient practices supported to enhance irrigation management.

“The non-observance of many ancient and highly beneficial customs connected with the irrigation and cultivation of paddy lands as well as the difficulties, delays, arid expenses attending the settlement of differences and cultivators relating to water rights, in the ordinary course of law, are found to be productive of great injury to the general of proprietors of such lands and it is expedient to provide a remedy for these evils.”

Participatory management strategies were mostly adopted in the irrigation sector in ancient Sri Lanka. Ancient rulers were obliged to provide water for the cultivation purposes of the people as duty bearers. In the process of providing water, rulers tend to assign duties upon people to perform mutually. The legal background of ancient Sri Lanka clearly elucidate that when the state obliged to preserve particular right for the sake of people at the same time

<sup>10</sup> Various organizations have advocated for an international convention on the right to water. <<http://www.watertreaty.org/>> Last visited 12.04.2017

<sup>11</sup> The Convention on the Elimination of All Forms of Discrimination against Women (CEDAW), adopted in 1979 by the UN General Assembly, <<http://www.un.org/womenwatch/daw/cedaw/>> Last visited 18.04.2017

<sup>12</sup> Adopted and opened for signature, ratification and accession by General Assembly resolution 44/25 of 20 November 1989. Entry into force 2 September 1990, <<http://www2.ohchr.org/english/law/crc.htm>> Last visited on 20.04.2017

<sup>13</sup> The Convention on the Rights of Persons with Disabilities was adopted on 13 December 2006 during the sixty-first session of the General Assembly by resolution A/RES/61/106. The Convention and its Optional Protocol opened for signature by all States and by regional integration organizations at United Nations Headquarters in New York on 30 March 2007. Available at <http://www.un.org/disabilities/convention/conventionfull.shtml>.

<sup>14</sup> General Comment No. 15 (2002), para 3.

<sup>15</sup> The Implementation of the Human Right to Water in Argentina and Colombia- M. Belén Olmos Giupponi\* Martha C. Paz <[http://ac.els-cdn.com/S1870465415000100/1-s2.0-S1870465415000100-main.pdf?\\_tid=869a1494-35ef-11e7-a66c-00000aab0f6b&acdnt=1494469033\\_f7dc40a6d358b101b0c8274237fa2a36](http://ac.els-cdn.com/S1870465415000100/1-s2.0-S1870465415000100-main.pdf?_tid=869a1494-35ef-11e7-a66c-00000aab0f6b&acdnt=1494469033_f7dc40a6d358b101b0c8274237fa2a36)> Last visited 22.04.2017

<sup>16</sup> <<http://www.justice.gov.za/legislation/constitution/SACConstitution-web-eng.pdf>> Last visited 16.04.2017

<sup>17</sup> 1949 Constitution of India, article 21. Protection of life and personal liberty.

people also abide to perform certain duty in order to enjoy the same right. It is evident to demonstrate that people could retain their rights by performing their obligatory duties cast upon them to preserve natural resources.

Participatory management system embedded with historical irrigation process witness to long-lasting sustainable water policy functioned in the ancient times. It is clear that participatory management system which influenced to protect water resources and inveterate profound faith on water were the root cause of the success of the ancient water policies. Hence it is desirable to educate people on their duty to preserve water before tend to claim their rights.

#### **IV. DUTIES CAST UPON PEOPLE TO ACHIEVE SUSTAINABLE DEVELOPMENT PERTAINING TO WATER**

The Sri Lankan Constitution does not expressly recognize the right to water as a constitutionally protected fundamental right nor does it expressly recognize the right to life as a fundamental right. However some fundamental rights in the constitution implicitly recognize the right to life. Accordingly it is evident to prove that there is a room for identify the right to water as a fundamental right which could extend the right under existing laws. Neither it has not ensured by the constitution nor abides by any statutory provisions to provide continuous water supply to its people by government as duty bearer under the customary international law. However people as right holders are not entitled to demand their rights without accomplishing their duties implicitly cast upon to preserve water resources. The constitution imposes a fundamental duty on every person in Sri Lanka to protect nature and conserve it riches by the Article 28(f) rather not enforced In the process of accomplishing sustainable

development right to water retains high priority. United Nations Sustainable Development Summit held on 2015 recognized the access to water and sanitation as one of the Sustainable Development Goal with broad vision of establishing right to water. Hence it is essential to accelerate and expand the implementation process of sustainable water management policies and laws for protecting and utilizing available natural water resources efficiently by all nations. Most effective definition given to the term sustainable development is “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” Sustainable development has emerged as a new paradigm of development, integrating economic growth, social development and environmental protection as interdependent and mutually supportive elements of long term development. It emphasizes a participatory, multi- stakeholders approach to policy making and implementation, mobilizing public and private resources for development and making use of the knowledge, skill and energy of all social groups concerned with the future of the planet and its people. According to the sustainable development principles responsibility to preserve natural resources including water was allocated mutually among both the state parties and individuals.

As per the principle of inter generational equality, the rights of the future generations should be protected by the present generations by segregating exploiting natural resources. It is a notion that is implicit in ecological sustainability, while giving responsibility to the present generation as the custodian of the plant for future generations. This principle has dragged from the Principle 1 of the Stockholm Declaration. “Man has the fundamental right to freedom. Equity and adequate conditions of life in an environment of a quality that permits a life of dignity and well- being and he bears a solemn responsibility to protect and improve the environment for present and future generations...” This principle further elaborates the responsibility of man to protect natural recourses rather than appearing for strengthening their rights.

<sup>18</sup> Participatory management in Sri Lanka's Irrigation schemes – International Irrigation Management Institute 1986- Government Policy in Participatory Irrigation Management – J Alwis <[http://www.iwmi.cgiar.org/Publications/IWMI\\_Research\\_Reports/PDF/pub034/Report34.pdf](http://www.iwmi.cgiar.org/Publications/IWMI_Research_Reports/PDF/pub034/Report34.pdf)> Last visited 12.04.2017

<sup>19</sup> Article 27(14) Sriyani Silva Vs. Iddamalgoda , OIC Police Station Paiyagala (2003) 2 SLR 63

<sup>20</sup> Bruntland, G (ed) 1987 our common future : The world commission on Environment and development, Oxford University Press, Oxford

<sup>21</sup> (UN 2002. 2002 Global Challenge Global Opportunities: Threats in sustainable development available. <<http://www.un.org/esa/sustdev/publications/indisd-mg2001.pdf> > Last Visit 02.03.2017

Principle 2 of the same declaration more over explains the requirement of safeguard the natural resources and natural ecosystems for the benefit of present and future generations. Apart from that preambles of the convention on biological diversity, Convention on the conservation of migratory species of wild animals, Convention on international trade in endangered species of wild fauna and flora further express the necessity of communal participation to preserve natural resources.

In the *Bulankulama v. Min. of Industrial Development* (Eppawala case) justice Amarasinghe rightly express the requirement of public participation to preserve natural resources. He observed that “international standard setting instruments have clearly recognized the principle of inter generational equity. It has been stated that human kind bears a solemn responsibility to protect and improve the environment for present and future generations. The natural resources of the earth including the air, water, land, flora and fauna must be safe guarded for the benefit of present and future generations. The non renewable resources of the earth must be employed in such a way as to guard against their future exhaustion and to ensure that benefits from such employment are shared by all human kind.

The right to development must be full filled so as to equitably meet development and environmental needs of present and future generations. The inter generational principle in my view should be regarded as axiomatic in the decision making process in relation to the matters concerning the natural resources and the environment of Sri Lanka in general particularly in the case before us. It is not something new to us, although memories need to be jogged.” This principle further adopted by the supreme court of Sri Lanka in the case of *Wattegedara Wijebandara Vs. Conservator General of Forest*. In this case court has pointed out the necessity of utilizing natural resources in sustainable manner and it automatically institute the public responsibility to preserve natural resources. However present legal understanding exhibit that the requirement of public participation to preserve natural resources in the process of establishing the rights associated with natural resources specially preserving right to water.

In the *Eppawala* case justice Amarasinghe interestingly reject the public trust doctrine and lead to a new pathway to formulate novel concept of public guardianship. He stated that “in my view is restrictive in scope and I should look at our resources and the environment as our ancestors did and our contemporaries do, recognizing the shared responsibility.”

Further he elaborates the nature of duty of the state to preserve natural resources on behalf of the people as “the organs of the state are guardians to whom the people have committed the care and preservation of the resources of the people. This accords not only with the schemes of government set out in the constitution but also with the high and enlightened conceptions of the duties of our rulers, in the efficient management of resources in the process of development.” Accordingly it is clear that the state has been considered as guardian rather than duty bearer in terms of preserving rights compiled with natural resources in the Sri Lankan Legal structure. Thus the people are liable to safeguard natural resources to preserve their rights in the process of clamming right to water.

## V. CHANGING THE APPEARANCE OF RIGHT TO WATER BY IMPLEMENTING RECIPROCAL OBLIGATIONS

Reciprocal means Bilateral, two-sided, mutual or interchanged. Reciprocal obligations are duties owed by one individual to another and vice versa. A reciprocal contract is one in which the parties enter into mutual agreements. This bilateral relationship could be posed in the field of human rights between duty bears and right holders. However it is clear that people and state parties are having consecutive mutual deal in terms of performing and establishing human rights. Duty bearers are actors those who have a particular obligation or responsibility to respect, promote and realize human rights and to abstain from human rights violations. This term is most commonly used to refer to State actors. Duty bearers are interact with rights holders those who are entitled to

<sup>22</sup> Birnie,p and Boyle, A. *International Law and the Environment* , Oxford University Press.

<sup>23</sup> Birnie,p and Boyle, A. *International Law and the Environment* , Oxford University Press.

<sup>24</sup> S.C. Application No. 884/99 (F/R)

<sup>25</sup> S.C.F.R. 118/2004 Supreme Court Minutes of 05.04.2007 page 18

demand their rights or demand to assure their privileges. The concept of human rights are defined as moral principles or norms which describe certain standards of human behaviour and are regularly protected as legal rights in local and international law. Among others certain rights have inherent nature of performance which demands mutual contribution from the right holders to uphold the right. Mostly these rights are accompanied by natural resources, for an instance right to water. Accordingly it is clear that right to water is not only a one way right which should ensure by the government but also incorporated with mutual responsibility of people which would promote reciprocal integrity. Thus the demanding nature of right to water should be given new approach of rights according to the reciprocal understanding.

## VI. DISCUSSION AND CONCLUSION

Global propensity towards the Right to Water and water scarcity menace triggered to moderate the water resource management in Sri Lanka from 1997 with the assistance of the Asian Development Bank and Food and Agriculture Organization of the United Nations. Although comprehensive Water Resources Act and Management Policy were drafted in the light of that massive project, none of productive legislation has been implemented to

counter future challengers of water resources in Sri Lanka. This research investigated the reasons affected to fruitless of existing water policies and most of the Water related statutes. Even though the right to water has partially recognized in Sri Lanka both people who threatened and already assaulted by the water scarcity have not effectively proceed to achieve right to water. The rationale behind this huge failure is long term withdrawal from the responsibilities cast upon the general public which was implemented during the ancient era. The solution for the research Problem which was investigated by this paper is very crucial and time consuming attitude changing procedure. Entire society should have to educate under various age categories and initiate awareness programs in relation to reciprocal obligation of the people to preserve right to water.

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<sup>26</sup> <<https://www.unicef.org/gender/training/content/resources/Glossary.pdf>> Last visited 16.04.2017

<sup>27</sup> <<http://www.childrensrightswales.org.uk/what-are-human-rights.aspx>> Last visited 12. 03.2017

<sup>28</sup> James Nickel, with assistance from Thomas Pogge, M.B.E. Smith, and Leif Wenar, December 13, 2013, Stanford Encyclopedia of Philosophy, Human Rights, Retrieved August 14, 2014

<sup>29</sup> <http://www.fao.org/docrep/003/x9419e/x9419e09.htm>

# STATE RESPONSIBILITY AND LEGAL FRAMEWORK OF SRI LANKA IN FOOD SAFETY

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**Abstract** - Using different kinds of chemicals for agriculturally produced foods is a common phenomenon in Sri Lanka. The use of chemicals can be seen mostly in each and every step in the cultivation process, from nursery level till it reaches customers. Particularly this can be mostly seen in fruit ripening process. Fruit ripening is a natural process and it takes some time for fruit to ripen naturally. However, it is very pathetic to note that farmers, sellers and distributors use chemicals to get a high profit in their businesses even in off seasons and to deal with transportation and distribution issues. In appearance, the chemical treated foods are very attractive, greener and more fresh looking than untreated food; however, now this has created many challenging issues such as health, environmental, social, economic and has now become even a threat to the right to life of people in Sri Lanka.

This research is basically a normative study, which focuses on the legal aspects of using chemicals for agriculturally produced foods. By adopting the rights based approach this study focuses on the State's responsibility to a human rights regime regarding food safety. This study describes the available international human rights provisions and domestic legal provisions in this regard. The main objective of this study is to critically analyze whether the existing law regarding chemical treated food is adequate to address the current needs of society with the standards prescribed by the international community.

**Keywords** - Food Safety, Right to health, Right to life

## I. INTRODUCTION

Using chemicals in Sri Lanka has a long history and it is revealed that this was first used in the anti-malaria campaign. However in later stages, being aware that the

use of chemicals may increase the profit level of farmers, they tended to use chemicals without considering the adverse situation which can result from using chemicals. Particularly this can be mostly seen in the fruit ripening process. Fruit ripening is a natural process and it takes some time for fruit to ripen naturally. However, it is very pathetic to note that farmers, sellers and distributors use chemicals for this process to get a high profit in their businesses even in off seasons and to deal with transportation and distribution issues.

In the current context, this situation has led to many challenges in Sri Lanka such as health, environmental, social, economic and finally now it has become a threat to the right to life of people of this country. As a health problem, Sri Lanka is now faced with a challenge of handling thousands of chronic kidney patients mainly in the North East provinces, where most of the people are engaged in farming as their livelihood. Chemical injection used by fruit sellers to ripen fruits can cause cancer among users. Further, calcium carbide which is used very commonly for fruit ripening is a carcinogenic chemical that contains traces of arsenic and phosphorous which are extremely hazardous to the human body. The hazards can have short term and long term effects on the human body. The symptoms of carbide poisoning include vomiting, irritation or burning sensation in the eyes and skin, skin ulcers, irritation in the mouth, nose and throat, among other effects. It can also cause mood disruption, memory loss and allergic reactions.

Spreading these chemicals into the environment has led to the pollution of water, soil and even air, creating problems not only to the generation living now, but also to the future generations. Particularly chemicals such as Cadmium have led to the pollution of water at mass level. The chemicals



which are mixed in the soil start the pollution, and farmers themselves who used these chemicals have become the victims of several chronic diseases. Further this situation has created different economic and social problems. Especially it can be seen that most of the farmers who have chronic kidney disease belong to the low income level and are unable to meet their essential medical expenses. This has led to a situation where their children are compelled to terminate their education in order to find the income for their families.

## II. OBJECTIVE OF THE STUDY

In this context, the main objective of this study is to critically analyze whether the existing law regarding this area is adequate to address the current needs of society with the standards prescribed by the international community.

## II. THEORETICAL FRAMEWORK

The main theory that runs through this study is the human right based approach; which is a conceptual framework for the process of human development that is normatively based on international human rights standards and operationally directed to promoting and protecting human rights (UNICEF (2006)).

The elements of a human rights based approach have been well established for over a decade, following the adoption of the United Nations Common Understanding in 2003 that marked the beginning of a shift towards the further 'operationalization' of human rights.

The goal of this approach is to enhance the right mentioned in the UDHR and final output is to increase the capacities of 'duty-bearers' to meet their obligations and of 'rights-holders' to claim their rights. The seven main key principles are availability, accessibility, acceptability and quality of quality and services, participation, equality and non-discrimination and accountability.

## III. METHODOLOGY

This study is basically normative in nature. The author inquires about the laws governing the area of food safety globally and in Sri Lanka. The author has used UDHR, ICCPR, ICESCR and many other international

instruments and Sri Lankan Legislations as primary sources and various books, journal articles, case laws, and web resources have been used as secondary data for this study.

## IV. INTERNATIONAL HUMAN RIGHTS APPROACH TO THIS ISSUE

When analyzing this issue, the situation can be identified as one leading to a violation many rights, mainly including right to food. The right to food which is an inclusive right and it is not simply a right to a minimum ration of calories, proteins and other specific nutrients. It is a right to all nutritional elements that a person needs to live a healthy and active life, and to the means to access them. Improving nutrition is essentially a process of encouraging people to make healthful choices that improve their well-being. Although there is an argument for the categorization of human rights as declared by Article 5 of the Vienna conventions, human rights are universal, interrelated, indivisible and interdependent. This acknowledgement is quite similarly applicable to the right to food, as violation of the right to food can lead to the violations of many other economic, social, cultural rights and as well as violation of some major civil and political rights, including Right to life. If people are not adequately fed with food and if foods are not nutritious and safe enough, it can lead to a situation where the right to life is threatened. Moreover, violation of the right to food can be the origin for the violation of the right to health, right to water, right to adequate housing, right to education, right to work and social security, freedom of association, right to take part in public affairs, right to information, freedom from the worst forms of child labor and freedom from torture, cruel, inhuman or degrading treatment. Furthermore, the Committee of the Economic Social and Cultural Rights (CESCR) affirms that adequate food is indivisibly linked to the inherent dignity of the human person and is indispensable for the fulfillment of other human rights enshrined in the International Bill of Human Rights. It is also inseparable from social justice, requiring the adoption of appropriate economic, environmental and social policies, at both the national and international levels, oriented to the eradication of poverty and the fulfillment of human rights for all. (General Comment Number 12).

In this context state parties are bound by International obligations to protect the human rights of individuals of

a country and not taking effective and adequate actions against use of excessive chemicals in food production and processing can be considered as a violation of state obligations.

The right to food as a human right has been declared in many instances in human rights documents. As the core international human rights document, the Universal Declaration of Human Rights (UDHR) incorporated in 1948 after the establishment of the United Nation in 1945, recognizes the right to food in Article 25 in the context of an adequate standard of living stating that: “Everyone has the right to a standard of living adequate for the health and well-being and of his family, including food,.....”

The International Covenant on Economic Social and Cultural Rights (ICESCR) is fully committed to the protection and promotion of Economic Social and cultural rights in global and local contexts. It stipulated 31 main articles and among these articles, article 11 has specifically contributed to the recognition of the right to food, including food safety as follows.

Article 11 of the ICESCR.

1. The States Parties to the present Covenant recognize the right of everyone to an adequate standard of living for himself and his family, including adequate food, clothing and housing, and to the continuous improvement of living conditions. 2. The State Parties to the present Covenant, recognizing the fundamental right of everyone to be free from hunger, shall take, individually and through international co-operation, the measures, including specific programmes which are needed.
  - (a) To improve methods of production, conservation and distribution of food by making full use of technical and scientific knowledge, by disseminating knowledge of the principles of nutrition and by developing or reforming agrarian systems in such a way as to achieve the most efficient development and utilization of natural resources.
  - (b) Taking into account the problems of both food-importing and food-exporting countries, to ensure an equitable distribution of world food supplies in relation to need.

When looking at the overall meaning it can be noted that the literal meaning of the above text has tried to give priority to the adequacy of food rather than highlighting the quality level of the food and this article requests State

parties to take immediate and urgent steps that may be needed to ensure ‘the fundamental right to freedom from hunger and malnutrition.

However, the interpretation given to the above article as a general comment has elaborated the meaning of the right to food to clearly include the right to safe food into the meaning of the right to food. The Committee on the Economic, Social and Cultural Rights (CESCR) as the core treaty body working under ICESCR has elaborated the right to food in General Comment 12 in 1999. According to the interpretation of the Committee the right to adequate food implies

‘The Availability of food in a quantity and quality sufficient to satisfy the dietary needs of individuals, free from adverse substances, and acceptable within a given culture; The accessibility of such food in ways that are sustainable and that do not interfere with the enjoyment of other human rights.’

In a broader sense this interpretation required both quantity and quality foods to be available and two main areas can be identified in relation to the quality of food.

1. Food should contain a mix of nutrients for physical and mental growth, development and maintenance, and physical activities that are in compliance with human physiological needs at all stages throughout the life cycle and according to gender and occupation.
2. Food should be free from adverse substances. (Foods should be safe). This sets requirements for food safety and for a range of protective measures by both public and private means to prevent contamination of foodstuffs through adulteration and/ or through bad environmental hygiene or inappropriate handling at different stages throughout the food chain; care must also be taken to identify and avoid or destroy naturally occurring toxins.

Apart from the above definition of the right to food, some other interpretations also can be identified. Under the United Nations which has the mandate of protection and promotion of human rights, different kinds of mechanisms have been developed for this purpose and the appointing of Special Rappoorteurs can be seen. Under the current Human Right Council there is a Thematic Rappoorteur for the right to food and according to his report submitted in 2008, right to food means

“The right to have regular, permanent and unrestricted access, either directly or by means of financial purchases, to quantitatively and qualitatively adequate and sufficient

food corresponding to the cultural traditions of the people to which the consumer belongs, and which ensures a physical and mental, individual and collective, fulfilling and dignified life free of fear.”

Further, General Comment 14 which elaborates on the right to health as defined in article 12.1, is an inclusive right extending not only to timely and appropriate health care but also to the underlying determinants of health, such as access to safe and potable water and.....an adequate supply of safe food. Additionally the Committee reiterates the view expressed in General Comment No 12 that guaranteeing ‘access to the minimum essential food which is nutritionally adequate and safe, to ensure freedom from hunger to everyone’ is one of the core obligations incumbent upon State Parties to grant satisfaction of the minimum essential level of the right to health.

In different contexts, several international declarations and other soft law instruments have reaffirmed the individual right to adequate and safe food. The World Declaration on Nutrition, adopted by the Food and Agriculture Organization (FAO) International Conference on Nutrition in December 1992, asserts that “access to nutritionally adequate and safe food is a right of each individual” (para. 1); the 1996 Rome Declaration on World Food Security includes the States’ commitment to “implement policies aimed at eradicating poverty and inequality and improving physical and economic access by all, at all times, to sufficient, nutritionally adequate and safe food and its effective utilization” and the related Plan of Action provides that States “apply measures, in conformity with the Agreement on the Application of Sanitary and Phytosanitary Measures and other relevant international agreements, that ensure the quality and safety of food supply, particularly by strengthening normative and control activities in the areas of human, animal and plant health and safety”; the Draft Principles on Human Rights and the Environment of 16 May 1994 state that “all persons have the right to safe and healthy food and water adequate to their well-being” (para. 8); the Declaration adopted at the FAO World Food Summit five years later in June 2002 confirms “the right of everyone to have access to safe and nutritious food” (preamble); and the 2007 Beijing Declaration on Food Safety reiterates the statement of the 1992 Declaration on Nutrition. Moreover, the view that “food safety and food security are inseparable” has been at the basis of the Pan American Health Organisation (PAHO)/WHO Plan of Action for Technical Cooperation in Food Safety that acknowledges that food safety and security “jointly contribute to progress

toward the attainment of the Millennium Development Goals, particularly the reduction of hunger and poverty.” Likewise, the FAO report on Ethical Issues in Food and Agriculture states that “achieving food security requires: (i) an abundance of food; (ii) access to that food by everyone; (iii) nutritional adequacy; and (iv) food safety”. The United Nation has adopted two main programs namely Millennium Development Goals (MDG- From year 2000-2015) and Sustainable Development Goals (SDG-2015-2030) to achieve human rights targets and the right to food has been identified as the target number 1 of the MDG and goal number 2 in SDG (End hunger, achieve food security and improved nutrition and promote sustainable agriculture). However it can be noted that much attention of these goals have focused on the issue of adequacy of food rather than speaking about the quality of the available food.

Under the international obligation undertaken from the above mentioned international instruments State parties are required to perform certain obligations. In relating to right to safe food, State parties are obliged to take action under the broad right to food and right to health acts. As mentioned in paragraph 36 of the General Comment, Number 14 relating to the right to health the Committee makes it clear that State parties are under obligation to adopt domestic law aimed to ensure ‘the underlying determinants of health, such as nutritiously safe food and potable drinking water’ and to provide for implementation of such legislation. Additionally the CESR draws attention to the obligation to safeguard all individuals under the State Parties’ jurisdiction from health hazards deriving from the activities of third parties (especially private actors such as individuals, groups or cooperations), including the expressly mentioned duty to protect consumers from dangerous practices by food manufactures.

According to Article 2 of the ICESCR, State Parties are required to take steps to give the ‘progressive to full realisation’ of the economic, social and cultural rights which are recognised under the ICESCR. The reading of this article shows that these implementations are not as urgent as the obligation provided under article 2 of the ICCPR where it required respecting and fulfilling the obligation immediately. However, even under ICESCR the minimum core obligations are set and states cannot deviate from such core obligations; for example a country would fully implement the right to health by the passage of time, but providing primary health is a core obligation of a state and a state, cannot wait for resources without fulfilling core obligations. In line with this point the CESR

reiterates the view expressed in General Comment No. 12 guaranteeing “access to the minimum essential food which is nutritionally adequate and safe, to ensure freedom from hunger to everyone” is one of the core obligations incumbent upon States Parties to grant satisfaction of minimum essential levels of the right to health.

## V. SRI LANKAN LEGAL FRAMEWORK REGARDING THIS ISSUE.

When considering the rights based approach it is sad to note that Sri Lanka does not recognize the right to food or right to health as fundamental rights by its 1978 Constitution. Neither has Sri Lanka recognized the right to life explicitly as a fundamental right. However the Supreme Court of Sri Lanka recognized the right to life for individuals with the land mark case of Sriyani Silva Vs Iddamalgoda, Officer in Charge, Polica Station Payagala ((2003) 2 SLR 63). Apart from the rights based approach Sri Lankan law relating to this issue is mostly covered by the different statutes provided under different names in different areas.

The National Food Act No 26 of 1980 and subsequent amendments have referred to food safety in Sri Lanka. Article 2 of the above law states that ‘No person shall manufacture, import, sell, expose for sale, store or distribute any food (a) that has in or upon it any natural or added deleterious substance which renders it injurious to health; and (b) that is unfit for human consumption, etc.... Further this Act makes provisions to consider anyone who breaches the provisions of the Act as a person who is guilty of an offence which is liable for a conviction.

The other main Act in this regard is the Consumer Affairs Authority No 09 of 2003 which speaks on the different aspects of protecting consumers against goods which are hazardous to human life. Moreover the Health ministry also has issued circulars in this regard. Control of Pesticides Act, No. 33 of 1980 is one other Act which provides provisions in this regard. Article 20 of the Act states that “No person shall harvest, or offer for sale any food crops, in which pesticides have been used unless a time limit as may be prescribed by regulations has elapsed between such use and harvest, or if the food crops shall contain pesticide residues in excess of levels as may be prescribed”. Apart from these laws, gazette notifications and regulations issued under the Food Act also available in

Sri Lanka. These gazette notifications have covered areas such as food hygiene, food standards, food preservatives, food sweeteners, etc...

## VI. ANALYSIS, CONCLUSION AND RECOMMENDATIONS.

Having considered the above situation, it can be concluded that Sri Lanka has taken few steps relating to adding chemicals for agriculturally produced foods. However it is apparent that, this problem is increasing day by day. Despite the existing law, it is not enough to cover all problems which have arisen in Sri Lanka. On the other hand, there are implementation problems in the existing laws which create loop holes and thus protection for wrong doers. The testing facilities in this regard are not adequate and not up to the required standards and there is a problem of a lack of qualified human resources in the respective institutions that should attend to these matters. Further, Sri Lanka has not yet prescribed a national list of acceptable pesticides, drugs and associated maximum residue limits. This has opened pathways to import unacceptable pesticides and also food stuffs with chemical residues, even though they are harmful for the human body. Therefore it is high time to prescribe this list. Furthermore, food safety is multifaceted which has to be understood carefully. However in Sri Lanka, institutions which are working pertaining to this issue; namely, the Department of Agriculture, The Consumer Affairs Authority, Ministry of Health, Sri Lanka Custom, The Sri Lanka Standards Institute, most of the time do not have a interrelationships and co-ordination between each. Therefore it is recommended to create a central co-ordination unit which can link all necessary stake holders. Example can be traced from Canada where they have a Canadian Food Inspection Institution which co-ordinates all institutions.

Most farmers, distributors, sellers and consumers are not aware of the harm which can be caused by chemical subsistence. Therefore, it is recommended to increase the level of knowledge among them. Farmers should be educated with safe technology which they can use for their cultivations and the harm caused by using excessive loads of chemicals for foods. Further, distributors and sellers should be educated about the proper ways of storage, transportation and food safety methodologies. Consumers also should be educated about the ways of differentiating foods with added chemicals from natural foods.

The attitudes of consumers should change to buy non-toxic foods even though those foods are not attractive enough as are chemical added food.

Finally the main argument of this research paper states that the rights based approach can be utilized as a form of questioning this unethical practice. According to Human Rights obligations, a state should protect, promote and fulfill rights which are contained in conventions on behalf of the individuals of the country. The meaning 'protect' has been interpreted in a broader manner where it expects the government to take actions when a right of a person is violated even by a third party. In this context the threat to right to life, right to health are entitled to be questioned even though violations occur from a third party. A state cannot move away from the obligations which they have undertaken. Therefore it is imperative for Sri Lanka to consider these aspects and consider incorporation of the right to health as a fundamental right. On the other hand, the Judiciary as the last hope of people should be ready to declare progressive and creative interpretations in their judgments understanding the international obligations undertaken by Sri Lanka.

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# TRIUMVIRATE OF TRANSBOUNDARY MOVEMENTS OF HAZARDOUS WASTES AND DEVELOPING COUNTRIES

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**Abstract** - For decades, poorer countries have been used as dumping sites for unwanted wastes, particularly those classified as 'hazardous,' by the developed industrialist countries. As a result, developing world has to tackle a myriad of issues arising out of solid waste dumping while ensuring the safety of the environment and the human lives. The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal sought to address this crucial issue but the burden of wastes generated in the developed world is still, to a greater extent born by the developing world which stands in clear violation of the well-recognized principles of international environmental justice.

This research therefore seeks to address the problem, how the developing world is still being a graveyard of wastes which generates negative impacts on the environment and human lives notwithstanding the legal instruments and principles that seek to regulate transboundary waste dumping and their impacts on human lives and the environment?. The objectives of the research are to analyse the role and application of 'Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal' in the movement of wastes into the poorer countries by the developed world, to determine whether it contributes towards the establishment of environmental justice and to find out the factors that hinder the effective use and implementation of the Basel Convention.

The research was carried out using the black letter approach to research based on primary sources viz. legislations, judicial decisions and international treaties and secondary sources viz. books, journal articles, previous research studies and online sources. Gathered data will be interpreted in light of the theory of environmental justice.

The study concludes that the proper implementation of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal is necessary to protect the environment and to meet sustainable development goals.

**Keywords** - Environmental Justice, Transboundary Movements, Hazardous Wastes, North South Division.

## I. INTRODUCTION

During 1970's and 1980's there had been a heightened public concern in the developed world on negative impacts of hazardous wastes on human lives and the environment which forced the domestic law-making authorities to enact legislations that deal with waste disposal and their adverse impacts. This on one hand reduced waste dumping sites and on the other hand increased the costs of waste disposal (Andrews 2009). Consequently, the developed world had to resort to alternate mechanisms to get rid of wastes and the most popular of these methods involved the export of wastes to the developing or poorer countries by way of second hand trading. Accordingly, since 1980s there has been an increase of the waste shipments from developed countries to the developing countries and according to the statistics there had been 3.6 million tons of such waste shipments between 1986 and 1988 (Moyers, 1990).

This new trend resulted in a number of crucial issues most significant being the Koko Nigeria disaster in 1988 and the case of the Khian Sea in 1980's (Gutierrez 2014). These incidents emphasized the importance of adopting an international instrument to deal with Transboundary Movements of Hazardous Wastes and their Disposal. As a result, the Basel Convention on the Control of

Transboundary Movements of Hazardous Wastes and their Disposal (Basel Convention) was drafted and concluded on 22 March 1989 with 35 states as its first signatories and came into force in 1992.

The objective of the Basel Convention is to protect human health and the environment against the adverse effects of hazardous wastes. Its scope of application covers a wide range of wastes defined as “hazardous wastes” based on their origin and/or composition and their characteristics, as well as two types of wastes defined as “other wastes” - household waste and incinerator ash (Secretariat of the Basel Convention 2011).

Since the adoption, Basel Convention has gone through a number of milestone developments most significant being the Ban Amendment adopted by the third meeting of the Conference of the Parties (COP) in 1995. The Ban Amendment provides for the prohibition of ex-ports of all hazardous wastes covered by the Convention that are intended for final disposal, reuse, recycling and recovery from countries listed in annex VII to the Convention.

COP adopted Annexes VIII and IX to the Convention, which provide further elaboration as to the wastes regulated by the Convention in 1998 and the Basel Protocol on Liability and Compensation for Damage resulting from Transboundary Movements of Hazardous Wastes and their Disposal in 1999. In 2002, a Committee was established by COP to administer the Mechanism for Promoting Implementation and Compliance and further adopted a Strategic Plan for the implementation of the Basel Convention for the period 2002 to 2010 and a partnership programme with business and industry. The Bali Declaration on Waste Management for Human Health and Livelihood which affirmed that if waste is not managed in a safe and environmentally sound manner it may have serious consequences for the environment, human health and sustainable livelihood was adopted in 2008 (Secretariat of the Basel Convention 2011).

Notwithstanding all these landmark developments, developing world still provide graveyards for hazardous wastes flowing from developed countries taking on irreversible environmental and life-threatening risks. It is estimated that from 2000–2010 alone, more than 600 million metric tons of hazardous wastes were generated globally (Pratt 2010), a major portion of which was emanated from industrialist countries (Neil 1998, Lipman 2011). These wastes are exported to developing countries for number of reasons (Mason 2006) and according

to some researchers many of the wastes exported to developing countries are unaccounted for (Okaru 2011). These wastes coming from the developed countries impose life threatening environmental and health hazards in the developing countries which are further heightened by the inability of these countries to deal with such wastes in an environmentally sound and sustainable manner (Dimitri 2014).

This research therefore seeks to address the problem how the developing world is still being a graveyard of wastes which generates negative impacts on the environment and human lives notwithstanding the legal instruments and principles that seeks to regulate transboundary waste dumping and their impacts on human lives and the environment?. The objectives of the research are to analyse the role and application of ‘Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal’ in the movement of wastes into the poorer countries by the developed world, to determine whether it contributes towards the establishment of environmental justice and to find out the factors that hinders the effective use and implementation of the Basel Convention.

## II. METHODOLOGY

The research was carried out using the black letter approach of research based on primary sources viz. legislations, judicial decisions and international treaties and secondary sources viz. books, journal articles, previous research studies and online sources. Black letter approach was used since it is necessary to carry out an in-depth, critical and an objective analysis of the principles of the Basel convention in light of the environmental justice theory in order to answer the problem sought to be addressed in the study.

## III. TRIUMVIRATE OF TRANSBOUNDARY MOVEMENTS OF HAZARDOUS WASTES

### A. Environmental Justice

This research seeks to analyse the issue of movement of wastes from developed countries to developing countries in light of the theory of environmental justice while analysing whether the principles recognized in the Basel convention ensure environmental justice.

According to United States Environmental Protection Agency Environmental justice mean the fair treatment and meaningful involvement of all the people without discrimination on any ground what so ever in the environmental governance. It simply argues that everyone has an equal right to the enjoyment of the environment and every person shall bear an equal burden of environmental risks. If only one person or a particular group of persons are compelled to bear the risks of environmental damage due to procedural, geographical, social, economic or any other reason it will amount to environmental injustice or environmental racism.

When the hazardous wastes emanated in the developed countries are exported into the developing countries due to economic or any other reason (except for a fair reason like recycling), such practice forces a total different community to enjoy an inferior environment and to bear all the negative consequences arising out of it including threats upon health and human lives for the sake of betterment of the developed countries. It stands in clear violation of environmental justice and all the equities connected with it. The only reason why the developing country citizens are exposed to such a hazard is merely because they are economically inferior to the developed country.

In order to address this injustice both developing countries and developed countries shall be considered in an equal footing and both sets of countries shall be given the choice of being the exporters and importers of wastes enabling the authorities that exercise sovereign power in such jurisdictions to decide whether they are allowing the access of a particular waste into its territorial limits or not.

### **B. North South Divide**

The exercise of international environmental justice has however been hindered by the North South divide in the environmental governance. According to the existing studies the leading cause of global environmental degradation is the profligate consumption of the planet's resources by its wealthiest inhabitants, most of whom reside in the global North or in the mega-cities of the global South. The richest twenty per cent of the world's population consumes roughly 80 per cent of the planet's economic output, and generates 90 per cent of its hazardous waste (United Nations Millennium Ecosystem Assessment 2005). For centuries, a set wealthy nations are exploiting the resources of poorer countries who are trapped in the vicious cycle of poverty paying their price

for the environmental pollution caused by industrialist countries and losing opportunities for development (Gonzalez, 2015).

South is bearing a disproportionate burden of costs of activities of the North due to their geographic location, lack of laws and regulation and even due to lack of power in the international arena to stand against the acts of so-called powerful nations, more specifically since wealthy nations hold the controlling power of most of the key international decision-making bodies including World Trade Organization, World Bank, International Monetary Fund and even the United Nations.

### **C. The Basel Convention on the Control of Transboundary**

**Movements of Hazardous Wastes and their Disposal**  
Any legal instrument that seeks to address the complicated issue of transboundary movement of hazardous waste shall be fully equipped to establish environmental justice over North South dimensions of environmental governance.

Article 4 of the convention deals with the general obligations of the parties to the convention. It recognizes the sovereign right of any party to prohibit the import of any hazardous waste and the obligation of the other party to respect such decision (Article 4 (1)). This sovereign power is further strengthened by Article 6 which mentions that the international trade of hazardous wastes shall be based on the Prior Informed Consent (PIC) procedure and conducted in accordance with the principles of Environmentally Sound Management (ESM). These principles allow every country without discrimination on the basis of economic status, political power or any other ground to take independent decisions with regard to acceptance or rejection of wastes.

Article 4 (2) (a) recognizes the obligation of the state parties to reduce the emanation of hazardous wastes and other forms of wastes to the minimum taking into account social, technological and economic aspects and Article 4 (2) (b) lays down the necessity of having adequate disposal facilities within the territorial limits of the country which generates wastes. This obligation is further supplemented by Article 4 (9) which permits transboundary waste disposal only in definite instances provided in the convention. It is either where the exporting state does not have the technical capacity and the necessary facilities or suitable disposal sites or where the wastes are required by the importing state as raw materials for recycling or



recovery industries. These principles seek to ensure that the burden of disposing wastes will be born to the maximum extent possible by the territory which generates such waste without unnecessarily passing an alien environmental burden to a separate country unless it is for the benefit of the wider community.

According to article 4 (5) a party shall not permit hazardous wastes or other wastes to be exported to a non-party or to be imported from a non-party. It ensures that the parties to the convention do not impose an environmental burden on a vulnerable state not regulated by the convention or takes on an environmental burden which cannot be regulated by the convention.

Article 4 (8) mentions that The Convention places an obligation on both the importing and exporting country Parties to ensure that hazardous wastes that are exported are managed in accordance with ESM. Further Article 9 of the Convention lays down a procedure to deal with instances of illegal traffic of hazardous waste.

These basic principles of the Basel convention ensure that the environmental justice principles are upheld and respected in transboundary movement of hazardous wastes. However, the Basel convention has a number of loop holes which when combined with the North South division of environmental governance create crucial environmental injustices.

## IV. BASEL CONVENTION: THE DARK SIDE

Basic loophole in the regulation of transboundary movement of hazardous wastes is that some of the major industrialist countries including USA are not parties to the Basel convention, which means that they will follow their own rules in exporting and importing wastes. This is one major factor that hinders the effectiveness of the Basel convention in the practical scenario.

This can have serious adverse impacts on the environmental justice, environment, human lives and health since in practice developing countries are at the mercy of developed countries (basically due to monetary needs and the need of financial support) and might voluntarily takes up the burden of hazardous wastes due to economic gains that derives from it even in the absence of proper regulation in contrary to the provisions of the Basel Convention.

Article 4 (9) (b) of the convention permits transboundary movement of hazardous wastes for the purposes of recycling. This principle has been a door through which different types of hazardous wastes sought entry into other countries which have not been necessarily aimed at using in recycling processes.

Further, the Prior Informed Consent fails to properly verify that the facility in the receiving state which accepts waste can manage such waste in an environmentally sound manner. Moreover, the technical guidelines of environmentally sound management provided in the convention are not mandatory but discretionary in the domestic context. Therefore, exporting state will have to face a number of issues in getting the domestic technical standards properly verified and assessing whether they are environmentally sound.

The convention lacks provisions for liability and compensation for the violation of the obligations in the convention and pollution resulting from toxic waste. Protocol on Liability and Compensation sought to address this issue to a greater extent which recognize both strict liability and fault-based liability, however the Protocol imposes greater liabilities in cleaning up and remedying environmental damages for after-care incidences which is unfavourable to the poorer, developing countries.

Further the convention contains generally wider definitions which provides a little guidance to the parties to the convention. Most significant of these definitions is the definition given to environmentally sound management. According to Article 2 (8), Environmentally sound management of hazardous wastes or other wastes means taking all practicable steps to ensure that hazardous-wastes or other wastes are managed in a manner which will protect human health and the environment against the adverse effects which may result from such wastes. This definition is too general therefore depends upon each states discretion to decide what exactly is environmentally sound which hinders the assurance of environmental justice and sustainability.

## V. RECOMMENDATIONS

Due to above loopholes, this study suggests that it would be significant to create a separate international institution to ensure that the provisions in the Basel Convention are adequately complied with by the member countries. This institution shall monitor whether the hazardous wastes exported in to the developing countries are re-

usable and re-cyclable or not. Further there shall be a guideline which comprehensively defines hazardous wastes with a framework to identify waste with regard to each consumable and environmentally sound waste management mechanisms. Apart from that, the technical guidelines of environmentally sound management provided in the convention shall be made mandatory.

Moreover, irrespective of whether a particular country is a party to the convention or not, transboundary movement of hazardous wastes shall be regulated through *jus cogens*, peremptory norms of international law and other environment-related principles including state responsibility, polluter pays principle, precautionary principle, principle of sustainable development and most importantly the principle of environmental justice. In doing so, economic and political strengths of different states shall not be allowed to be a decisive factor and every state shall be treated equally.

Further, domestic mechanisms must be developed to recycle hazardous wastes which contain necessary allocations of human resources, novel technology and infrastructure. Apart from these social, management and technological factors domestic legal framework relating to recycling of hazardous wastes shall be developed. This can be done through upsurgeance of fines, imposing longer prison sentences, conferring more powers on the law enforcement authorities to carry out investigations and introducing spot fines. Further domestic laws shall take a proactive approach to prevent environmental damages arising out of hazardous wastes.

## VI. CONCLUSION

Developing world is struggling to achieve environmental justice particularly with regard to the use of their territories as waste dumping sites by the developing world. Basel convention contributes towards ensuring environmental justice to a greater extent yet certain loopholes together with North South conflict of environmental governance can in actual practice impose critically uneven environmental burdens on the developing countries. Basel Convention shall be developed to address these loopholes while encouraging all the states in the world to be a party to the convention and to take part in addressing the crucial issue of transboundary movement of hazardous wastes. Developing countries shall strengthen their domestic laws and policies to ensure environmentally sound management systems while maintaining their

independence in accepting and rejecting transboundary wastes. These mechanisms will reduce climate change issues, protect the environment and will facilitate the achievement of sustainable development goals.

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# THROWBACK ON THE PROCESS OF REGISTRATION OF CONDOMINIUM PROPERTIES

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**Abstract** - Most Condominium Property Developers, taking advantage of weaknesses in the procedural law on the registration of Condominiums, have dragged the Condominium Dwellers into a well woven cob web. Where, hopelessly Dwellers end up litigating against the Developer for fraud. However, in practical terms such a litigation situation is rare due to the lack funds to institute them.

Hence, the objective of the research is to analyse the loopholes of the existing domestic procedural law on the registration of Condominiums. Legal research methodology was followed. The source of library based secondary data review was referred to. Furthermore, a number of interview sessions were conducted for primary method of data collection. The mixed method was adhered to when establishing the recognized objectives. The identified stakeholders were Condominium Dwellers, Condominium Developers and the experts in the field of law related to Condominiums. It is evident that most Condominium Dwellers are not aware of their inherent rights. Hence, without this understanding on the statutory rights, they have faced with a number of issues that emanate from the registration process of Condominiums; specific reference to lack of a real transfer of title due to the conditional sale the parties enter into, the risk of not being able to be compensated from the insurance claims in case of a damage to the building and several other major adverse consequences. Hence, the intended research outcome is to introduce a policy paper with recommendations aiming to assist the law making commissions when amending the existing domestic procedural legal framework related to the registration of Condominiums. Establishing the fact that, Sri Lanka should encourage the living in Condominiums to cope up with the increasing migrants to urban areas, it could be concluded that it is a timely

requirement to make the Condominium Dwellers aware about their rights.

**Keywords** - Condominium Properties, Registration, Dwellers

## I. INTRODUCTION

The term Condominium housing refers to a form of occupancy, or rather a system of ownership in a complex of dwelling units which are individually owned. In other words, these are where the owners have complete title to the respective individual unit while holding a shared interest in the common areas of the Property which are known as 'common elements'.

Colloquially, in Sri Lanka the term "apartments" is interchangeably used for "Condominiums" regardless of the form of ownership.

However, the area of study of this research is not an apartment with a short term ownership or rented space but residential spaces with permanent long term ownership.

Currently, the demand for living in Condominium Properties is at a rise; the reasons to which will be discussed in further areas to come.

Nonetheless, the driving need for 'mere shelter' has blind folded Dwellers of these Condominium Properties, against many cracks that are prevalent in the contracts that they enter into with the Developers of the Property.

Therefore, the area of study is the loopholes of the procedural law related to Condominium Properties, with specific reference to the registration process of the Condominium Property.

Hence, the rationale of this research is to voice out the unheard yearnings of the Dwellers of Condominium Properties who are unaware about their valuable rights; hence, have no bargaining power to fight for their own rights.

## II. METHODOLOGY

Legal research methodology was followed. The source of library based secondary data review was referred to. Furthermore, a number of interview sessions were conducted for primary method of data collection. The mixed method was adhered to when establishing the recognized objectives. The identified stakeholders were Condominium Property Dwellers, Condominium Property Developers and the experts in the field of law related to Condominium Property.

## III. RESULTS

The expected outcome of the research is to introduce a policy paper which would have a prime focus on amending the existing law on Condominium Property by introducing stricter procedural regulations on the process of the registration of the Condominium Properties.

Attention of the law making commissions is wished to be diverted towards the fact that the Condominium Property Dwellers would be subjected to the undue suppression of the Condominium Property Developers if the law on Condominium Property is not amended with immediate effect keeping in mind that the demand for high rising residential buildings is at a rise.

This continuance of the silent treatment towards the area of registration process of Condominium Properties, would result in a high chance of increase in the litigations by the Condominium Property Dwellers against the Condominium Property Developers.

## IV. DISCUSSION AND CONCLUSION

United Nations estimates suggest that the population of Sri Lanka, as at April 2017, is 20,881,868; an equivalent of 0.28% of the total world population. Despite of the declining nature of the yearly population growth rate, Sri Lanka ranks number 58 in the list of countries by population while holding a population density of 333

per Square Kilometre (total land area of Sri Lanka being, 62,702 Square Kilometres).

Noting that the population has been reflecting an upward trend, it can be seen that 19.4% of this total Sri Lankan population have opted to reside in the urban areas. This has been widely due to the easy access to quality education, need for a quality lifestyle, possibility of being recruited for better paying job opportunities and many other demographical and economical reasons.

With the movement of persons dispersed across the island into urban areas, a scarcity of accommodation facilities has arisen. This is because, it is naturally impossible for a limited urban area, which is holding only a very restricted piece of land, to provide bearing for commercial buildings, residential constructions, infrastructural erections and also shelter for the new entrants from the rural wilderness.

Hence, the demand for “Vertical Growth” over “Horizontal Growth” has been created.

### A. Area of Scope

The scope of the research is not on identifying the loopholes of the entire law on Condominium Properties. Instead, the researcher wishes to focus very specifically on the procedural handicaps in the law related to the registration process of the Condominium Properties.

The analysis made the researcher to understand that, most Condominium Property Dwellers are with the perception that they are with the complete control and ownership of the Condominium Property unit that they dwell in. However, from a legal aspect, when a dive is made into the real estate ownership the dweller has, it was realized that they, rather have a possessory control over the Condominium Property unit and not a real ownership.

Having established that most Condominium Property Dwellers are mere possessors and are not owners of the Condominium Property units they dwell in, they now come to face many other difficulties in various other aspects which is expected to be addressed in detail in the discussion to come.

It has to be noted that, the researcher under no circumstance holds the view that Condominium Property concept must be eliminated from the theory of real estate. As it would be seen irrational and unacceptable when taken hand in hand with the high urbanizing trend that is developed in Sri Lanka just as in Singapore.

Instead, developing a more stringent Condominium Property registration system, is suitably commended.

### **B. Loop in the Procedural Law Related to the Registration Process of the Condominium Properties**

The law requires the developer to register a subdivided building at least twice to bring it into the ambit of the law - firstly, to enable pre-sales of units, registration as a Provisional Condominium Property; secondly, upon completion of construction and issuance of the Certificate of Conformity, registration of the subdivided building as a completed Condominium Property (Edirimane, A., What Ails the Condominium Industry in Sri Lanka?).

Therefore, it can be seen that a Condominium Property comes into existence with the registration of the Deed of Declaration along with the Condominium Plan describing the individual Condominium units and the common elements of the building duly which are executed under the hand of the owner/s of the land in the presence of a Notary (Edirimane, A., Condominium Properties in Sri Lanka – Issues of Concern for Buyers and Sellers).

The Deed of Declaration embodies a principle document which explains the plan of subdivision which is also referred to as a 'Condominium Plan' in respect of a completed building, a 'Semi Condominium Plan' in respect of a partially constructed building and a 'Provisional Condominium Plan', in the case of a building which is yet to be constructed (Edirimane, A., Condominium Properties in Sri Lanka – Issues of Concern for Buyers and Sellers).

It is only then that the Condominium Property would be considered a separate immovable Property from the land to which it is attached. This in other terms is known as the "subject matter of sale" in a sale of immovable Property agreement.

Hence, it could be derived that, if there is no "subject matter of sale", there would not be a legally binding transfer of title to the Condominium Property buyer even at the expense of making the payment of the full consideration. Thus, title cannot pass to a buyer of a Condominium unit unless and until the subdivided building has been registered in terms of the Apartment Ownership Act No. 39 of 2003 giving recognition to Condominium units reflected in the plan of subdivision as individual immovable Property (Edirimane, A., Condominium Properties in Sri Lanka – Issues of Concern for Buyers and Sellers).

However, as identified above, the developer has to register the subdivided building at least twice as a Provisional Condominium Property and as a completed Condominium Property in order to bring it within the legal framework. As a result, the registration procedure is taken as to be burdensome and expensive due to the requirement of the dual registration system when in actual terms a single registration would have been suffice.

Therefore, it is natural to expect from majority of Developers to avoid themselves from registering the Provisional Condominium Property. As a result of which, it could be seen that most pre-sales of units take place with no specific reference to a registered plan, allowing such sales to take place without a legally recognized subject matter (Edirimane, A., What Ails the Condominium Industry in Sri Lanka?).

Hence, it is vital to make the Condominium Property Dwellers more aware about the difference between ownership and mere possession. If not, due to the inherent weaknesses in the registration system of Condominium Properties, the innocent Dwellers, despite of having paid their valuable consideration, would have to face numerous complexities as identified below.

#### **1) Conditional Sale:**

It can be very clearly seen that, due to circumstances described above, an incomplete or no registration of Condominium Properties take place. Hence, there would not be a "subject matter of sale". In the absence of such a subject matter, which is an essential requirement for a sale, the transaction between the dweller and the developer of the Condominium Property would be void in ab initio.

This is because then, there is no real transfer of title in exchange to the advance payment or full consideration paid by the dweller. Hence, instead of owning the ownership title the dweller would merely hold the title of possessor.

#### **2) Insurance:**

Suppose the Condominium Property collapses due to an earthquake, under usual circumstances the Condominium Property would be compensated for the loss or damage caused on to the Condominium unit owned.

In contrast, if the Condominium unit is merely possessed and not owned by the dweller, the resulting effect would be different. This is because the insurance proceeds would be

released to the owner of the land and not to the possessor of the unregistered Condominium unit.

### 3) Condominium Management Corporation :

Generally, as statutorily required, every Condominium Property should consist of a Condominium Management Corporation. This needs to be registered at the Condominium Management Authority. Hence, a Condominium Management Corporation comes into existence with the registration of the Condominium Property.

The Condominium Management Corporation is a collection of the owners of the units of the Condominium Property and is in charge of the maintenance of the Condominium Property and represents the Condominium Property at various occasions.

Therefore, if the Condominium Property is not registered, the prospective buyers of its units will not be a part of a Condominium Management Corporation. This in turn, neither privileges the prospective buyers over the undivided portion of the common elements due to the lack of a valid title to a Condominium unit nor would they be benefitted by monthly maintenance of the building being carried out, as no management fees would be collected due to the absence of a Condominium Management Corporation (Edirimane, A., Condominium Properties in Sri Lanka – Issues of Concern for Buyers and Sellers).

### 4) “Prospective Dwellers”:

Moreover, it could be seen that the prospective Dwellers are mere Dwellers or possessors and not real owners. They gain title, neither over the building nor over the Condominium unit.

This is because the building has not been recognized as a separate subject matter from the land to which it is attached due to the lack of registration of the Condominium Property.

Therefore, if the developer fails to complete the construction of the structure or fails to provide the agreed facilities, the dweller would not be able to voice out to recover the financial damage the dweller faces with.

### 5) Condominium Property Developer or rather the Condominium Property Dictator:

It has to be noted that, if the Condominium Property is not registered as a separate Property from that of the land on which it is built, in realistic terms, the Property is not actually owned by those who pay valuable considerations for the development of it. Rather, it is owned by the land owner upon which it is built.

If the land owner and the developer are the same bodies, then, the developer could easily exert his unfettered discretion on the premises.

For instance, it was discovered that certain Developers dictate the parking spaces, gymnasiums, swimming pools, elevators and the restaurants which are in fact, common elements which are jointly owned by the owners of the units on a share value basis in other properly registered Condominium Properties.

Moreover, the researcher came across many Condominium Properties in Wellawatta (names withheld), where the Developers run their own businesses in the main entrance and common elements. At times, such businesses have been disruptive to the daily lifestyles of the Dwellers of the Condominium Properties.

### C. Solutions; Teething the Law Governing the Registration Process of Condominium Properties

First most suitable step that the prospective Dwellers of Condominium Properties should undertake prior to making any payment of valuable consideration is to, investigate if the building is registered as a Provisional Condominium Property under Act No. 39 of 2003.

This would address every possible complexities that the prospective owner may face in the future as analysed above. Statutorily a process of action must be created to ensure that, this is done by the prospective Dwellers.

Moreover, the prospective owner of the Condominium unit should clarify the rightful ownership of the designated land. This investigation of records of the local authority would provide solid evidence to the buyer if whether the land has been transferred to the developer from the actual owner of the land.

This would hold back the prospective buyer from falling into a fraudulent Property ploy.

Furthermore, as researched, the prospective buyer could enter into a Reservation Agreement. This would allow the potential buyer to reserve from the agreement or rather remove oneself from being a party to the agreement, if the buyer gets to know that the developer has not registered the building as a separate Property from that of the land on which it is constructed. Thereby it allows the potential buyer to reclaim the advance payments made by the party, prior to the termination of the sale and execution of the Agreement of Sale.

Statutory provisions must be made with this regard to ensure that the agreement between the dweller and the developer of the Condominium Property is inclusive of a clause with this regard.

Moreover, the parties could enter into an Escrow Agreement. This would allow the prospective buyer to compel the developer to deposit the funds taken from the purchaser in an Escrow Account.

Statutorily requiring an Escrow account, would ensure that the funds are kept with an independent neutral third party in a secured manner. So that, in case of failure in the contract of building the Condominium unit, the prospective dweller would not lose the funds invested.

Moreover the developer could be required to give full details of the proposed Condominium project, including a copy of the registered Master Deed, copy of the sale & purchase agreement, an explanation of the Escrow arrangement, a project budget for the first year of operation of the association of Condominium owners, etc., (Edirimane, A., Condominium purchase: Be informed).

This has to be made mandatory to the developer through the statute.

During the research it was identified that, proposals have been made to form an Association of Condominium Management Corporations dispersed across the island. The aim of the body should be to work with the Housing and Common Amenities Ministry and the Condominium Management Authority.

Through which, the different Condominium Management Corporations and the prospective buyers could share experiences in Condominium management with each other, make unified representations about common issues with Developers to Government bodies and suggest improvements to the existing legislation.

## D. Conclusion

In terms of the Roman Dutch Law, which applies to immovable Property in Sri Lanka, the owner of a building is the owner of the land upon which the building is constructed. (i.e. 'building goes with the land'). This concept changed after the enactment of the Apartment Ownership Law, which for the first time recognized vertical layers of a building, registered under its provisions, as a class of Property on its own giving the right of separate ownership for such subdivisions (Edirimane, A., Condominium purchase: Be informed).

Hence, with the boom in the Condominium Properties, the Dwellers in them were able to "privatize the air space above the ground and carve it into small blocks that could be sold for profit". This could be the reason why it is an accepted notion that the Condominium industry is no more in its infant stage but has reached its maturity.

Together with the mushrooming of skyscrapers in a haphazard manner, the need for a more observant look into the procedural aspect of the registration system of the Condominium Properties has arisen.

In fact, in *Mallika Fernando vs Nagesh Fernando* (C.A. 979/79 DC Colombo 16894/L : March 26, 2001), it was held that the registration of Condominium Property in Sri Lanka is not imperative under the Apartment Ownership law.

It could be seen that due to many reasons such as, inability to finalize the construction as per the plan or not as per the requirements of the Certificate of Conformity, common elements not adequately provided and the cumbersome nature of the process of registering Provisional Condominium Properties and completed or Semi Condominium Properties has made majority of the Developers of Condominium Properties reluctant to register or delay the registration process of the Condominium Properties.

Due to this, majority of the prospective Dwellers are now facing a massive problem. This is because, they have already paid the full consideration or an advance payment, however have not received a legal title of ownership over the particular Condominium Property.

This is because the Condominium Property has not been registered as a separate Property from that of the land on which the building was constructed.



As a result of this currently the prospective Dwellers have faced various complications such as the entire transaction taking the outlook of a conditional sale and not a real transfer of title. Moreover, they have faced with the risk not being able to claim their insurance recovery in a situation of a disaster as the insurance claim would only be given to the owner of the building (i.e. the developer or the owner of the land) and not the possessor of the Condominium unit. In addition, the Dwellers would not be able to institute a Condominium Management Corporation as they would not be recognized as owners of Condominium Properties.

Hence, it could be seen that unless and otherwise the above mentioned amendments are taken into consideration and making the procedural laws on the registration of Condominium Properties more stringent, the actual owners of the Condominium unit would continue to be possessors and Condominium Property developer would rather be the Condominium Property dictator.

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# REFORMS TO THE INTERNATIONAL TRADE REGIME FOR THE PROTECTION OF MARINE LIVING RESOURCES

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**Abstract-** The World Trade Organization (WTO) was established, as the successor to the General Agreement on Tariffs and Trade (GATT), through Marrakesh Agreement giving birth to new arenas of international trade. Though the main objective of the WTO is to promote free and fair trade among the member states, the draftsman of the agreement has clearly identified the need of addressing the interdisciplinary perspectives of trade.

There are number of agreements and provisions under the WTO umbrella, which focuses on these interdisciplinary issues including marine environmental concerns of international trade. Agreement on Technical Barriers to Trade, Agreement on Sanitary and Phiosanotary Measures and GATT provide explicit provisions to address trade related ecological issues. However, the world had witnessed a number of trade related marine eco system degradations where the Dispute Settlement Panels have used their discretionary powers in a trade favoured manner. This study is a literature based research that focuses on assessing the existing international trade regime in light of balancing global trade and marine environmental interests.

The foremost output of the study is that free trade or open economy is not always in conflict with the protection of natural resources provided if necessary regulations are in place. The focal point is that the provisions under the current regime are not efficiently and effectively implemented in order to ensure the proper balance between the two disciplines. In conclusion, the WTO needs to ensure that they promote not only fair and free trade but also a green trading system and for that purpose, the WTO should encourage the member states and Dispute Settlement Panels to promote world trade while keeping an eye on the international environmental standards.

**Keywords** - Marine living resources, International trade law, Trade related environmental disputes, Sustainable trade goals

## I. INTRODUCTION

The Dark era of the world history was the period of World War II which led to a halting of global commercial activities. The tariffs imposed by the developed countries were much higher during this time period. After World War II twenty three countries led by United States (US), United Kingdom and Canada started negotiation to create a multilateral agreement as a contributor for regulating world trade between state parties. The General Agreement on Tariffs and Trade (GATT) 1947 was the first multilateral agreement regulating international trade after World War II. GATT was established purely on economic interests, following the objective of promoting free and fair trade. Since 1947-1994 the primary objective of the GATT was to expand market access and eliminate tariffs and other barriers for liberalizing international trade.

However on the 1st of January 1995, The World Trade Organization (WTO) was established through Marrakesh Agreement giving birth to new arenas of international trade. Here the attention was drawn not only to the trade in goods, but also to trade in services, intellectual property rights and lot more. In the preamble to the Marrakesh Agreement (1995, p.09), it states '..... Allowing for the optimal use of the world's resources in accordance with the sustainable development.....'. This statement clearly indicates that the draftsman of the agreement has clearly identified the need of addressing the trade related environmental concerns and the need of fair exploitation of resources while establishing the inter-generational equity. Singer (1993, Ch.10) states 'If someone tries to justify any

environmental damage, they have to take in to account not only the value of environment to the immediate future but also the generations to come in remote future, which means the great power that WTO has, is coupled with a great responsibility to pay attention to prosperity of future generations as well as the present generation.

However, the world had witnessed a number of cases where trade related marine environmental issues were questioned and the Dispute Settlement Panels have interpreted the provisions of the WTO agreements using their discretionary powers in a trade favoured manner. As mentioned above, the sustainable development, protection and preservation of environment are some of the fundamental goals of the WTO. In the recent years, the trade related environmental issues were intensively discussed among WTO members, trade policy makers and academics. Steinberg (1997, p.231) states that 'the net result of WTO rules will maintain of, but little improvement in the level of global environment protection.' That is to say even if the existing WTO regulations are implemented in proper place, it will only help maintaining the current environment standards. If the standard needs improvement, then the regulations will have to be reformed according to the expectations of preserving environmental natural resources.

Steve Charnovitz (1999) observes that in the nonexistence of proper environmental regulation and resource management including marine resources, increased trade might cause so much unpleasant harm that the gains from trade would be less than the ecological costs. Therefore this paper tries to identify whether there are any deficiencies in the scope of protection provided to the marine environment under the current regime and drawbacks of the implementation process.

## II. METHODOLOGY

This study is conducted solely based on a literature review on the above mentioned topic. The reference is made to a huge collection of secondary sources such as multilateral trade agreements, published text books, local and foreign journal articles, international judgments with regard to the research issue and electronic based resources. Special reference is made to the adapted and unadapted panel reports of WTO Dispute Settlement Panels and Appellate Bodies decided on trade related marine living resources destruction. The research is done on the following line.

- Historical Background of WTO
- Existing legal framework for the reduction of trade related marine environmental destruction
- Case study on international trade related marine ecosystem degradation disputes
- Analysis of the existing legal and institutional framework for the effect of sustainable use of non-renewable marine resources

## III. RESULTS AND DISCUSSION

WTO does not cater a single agreement which explicitly accommodate trade related environmental measures; rather provisions involving ecological preservation including marine living resources are dealt in a variety of agreements namely, GATT, General Agreement on Trade in Services, Agreement on Sanitary and Phytosanitary Measures and Agreement on Technical Barriers to Trade. Though GATT was established with the primary objective of general elimination of quantitative restrictions to international trade, the GATT itself provides ten general exceptions to the provisions of the agreement, two out of which are environment related exceptions;

- Measures related to protecting human, animal and plant life (Article XX (b))
- Measures related to conservation of exhaustible natural resources (Article XX(g))

However this article refers to two main requirements, namely, measures should come under one of the ten exceptions provided and it should fulfil the requirements of "chepaeu". "Chepaeu" requires that the measure should not be applied in a manner that constitutes 'arbitrary or unjustifiable discrimination between countries where the same condition prevail' and it should not be 'a disguised restriction on international trade'. Article XIV of the General Agreement on Trade in Services (GATS) also includes exceptions similar to the above provision, one of which is same as Article XX(b) of GATT.

Agreement on Sanitary and Phytosanitary Measures (SPS) deals with the basic policy related to the food safety, animal and plant health and protectionism. These include sanitary and phytosanitary actions taken to protect the health of fish and wild fauna, as well as of forests and wild flora. SPS allows member countries to set their own standards with regard to its coverage. Restrictions can be imposed to the extent necessary to protect human, animal or plant life or health, provided they do not arbitrarily or unjustifiably

distinguish between countries where identical or similar conditions prevail. Agreement on Technical Barriers to Trade (TBT) deals with product standard issues. The eco-friendliness of the production process also can be taken as a consideration that comes under the purview of the TBT. Though the provisions relating to the safeguard of environment had been introduced by WTO umbrella, they had failed to provide due consideration to those recommendations in the practical implementation. In most of the time, the Dispute Settlement Panel decides the matters solely based on elimination of trade barriers. The panel in United States – Prohibition of imports of tuna and tuna products from Canada (US- Tuna and Tuna Products from Canada, 1982) had failed to appreciate the measures taken by United States (US) for the conservation of exhaustible marine natural resources.

Later in United States- Restriction on imports of tuna (US- Tuna/ Dolphin I, 1991) the US imposed certain import limitations on tuna and tuna related products which were harvested in a manner harmful to the dolphins in high sea, resulting in a massive number of dolphin deaths. As a result of this restraint, US banned the tuna and tuna products imported from Mexico. Then Mexico initiated the dispute settlement proceedings, demanding the US ban to be an unfair and arbitrary restriction on international trade. US supported their argument based on the exceptions in Article XX based on the need to protect the dolphins since it has become an exhaustible marine natural resource. The panel objected to the concern about the extra territorial marine environmental concerns, establishing that GATT is a trade oriented structure.

Again in 1998, after the establishment of the WTO umbrella, a case concerning trade and marine eco system was brought before the dispute settlement mechanism. United States- Import Prohibition of Certain Shrimp and Shrimp Products (United States- Import Prohibition of Certain Shrimp and Shrimp Products, 1998) was a dispute with regard to the enforcement of exceptions provided in GATT Article XX. A list of five endangered sea turtles had been recognized under the US Endangered Species Act of 1973. Under the provisions of the Act, US made it compulsory for the fishermen to use a Turtle Excluder Device (TED), when the fishing is done in high sea where there is a probability of encountering the sea turtles in danger of extinction. US provided technological and financial assistance to the Caribbean countries for the adaptation of turtle excluder devices, which was not given to the Asian countries. India, Malaysia, Pakistan together with Thailand brought an action challenging

the ban imposed by the US on the importation of shrimp and shrimp products which were harvested in a manner harmful to the recognized sea turtles. Again the US attempt to protect the endangered sea turtles was unsuccessful before the dispute settlement panel and Appellate Body, since they failed to satisfy the requirement of Chepaeu.

It is evident although there are sufficient provisions included in the WTO regime to protect the marine living resources; implementation process has become a barrier to the achievement of the sustainable development goal. In absence of proper enforcement mechanism to pursue the WTO's marine environmental obligations, the need for an appropriately balanced institutional and policy framework has moved toward the agenda.

#### IV. CONCLUSION AND RECOMMENDATIONS

The Green Economy Concept has become a global trend among many countries in the world, multinational companies and non-governmental organizations. Free trade or open economy is not always in conflict with the environment provided if necessary regulations are in place. The matter that the world has to face today is not whether WTO lacks adequate provisions to protect the environment, but rather the main focus has to be drawn to the point that the provisions under the current regime is not efficiently and effectively implemented. Reforming the current implementation process to recognize eco-friendly products, production processes and trading practices would create mutual benefit to both trade and marine environment.

Further the provisions do not specifically define the nature and scope of what exhaustible natural resources are, and what measures can be categorised as legitimate barriers to free trade. Therefore it is apparent that the term 'exhaustible natural resources' in Article XX(g) creates some kind of uncertainty. Since the agreement does not provide specific interpretation for such words, WTO Dispute Settlement Panel will have to interpret these provisions in conflicting situations, where they use their discretion in interpreting these terms in a trade favoured manner. Therefore it is necessary to bring reforms to define these phrases in order to establish the balance between trade and environment including marine living resources.

On the other hand implementation of legitimate environmental safeguards had been allowed only with

regard to properties of the product while eco friendliness of the production process has been kept unaddressed. Trade and consumption of eco friendly production process should be encouraged for the purpose of achieving the sustainable goals of the WTO.

In addition, the accountability and transparency of the rulings and opinions of the dispute settlement panels have always been criticised by Academics and Non-Governmental Organizations. Therefore introducing institutional reforms to the dispute settlement mechanism for the balancing of trade related multi-disciplinary matters is a timely requirement. The failure to acknowledge the trans-boundary effects of trade related environmental matters has created a huge global discussion on the drawback of WTO's side. Ultimately it is evident that WTO had failed to achieve its fundamental goal of sustainable development.

A better implementation mechanism is a timely requirement for the WTO to protect the marine environmental standards of the world. Rather than having a separate World Environmental Organization to deal with the matters of this nature, WTO has the ability to preserve the balance between trade and environment for the benefit of both current and future generations. Allowing legitimate trade related environment protection measures on countries based on their capacities would be justifiable towards all. Therefore WTO needs to outlook the concept of international trade in a broader sense and ensures that they promote not only fair and free trade but also protect the natural resources for the benefit of the generations yet unborn.

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# BEWARE IF YOU ARE BEING A CHEAP CHARLIE: USED GOODS AND MERCHANTABLE QUALITY

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**Abstract** - As specified by S.15 (2) of the Sale of Goods Ordinance No 11 of 1896 (SGO of 1896), where goods are bought by description from a seller who deals in goods of that description, there is an implied condition that the goods shall be of merchantable quality and when the sale is by sample, S. 16 (2) (c) specifies that there is an implied condition that the goods shall be free from any defect rendering them unmerchantable, which would not be apparent on reasonable examination of the sample. It is quite clear that this condition of 'merchantable quality', would award protection to a buyer who purchases goods in the usual way from a shop.

However, the question to be addressed in this context is whether a buyer who purchases used goods (second hand goods) is entitled to the same level of protection under the SGO of 1896 as received by a buyer of a brand new product. Utilizing the black letter approach, this doctrinal research aims to find out the solution for the above problem. Further, the comparative analysis method is used to examine the distinctions between the statutory provisions in the SGO of 1896 regarding 'merchantable quality' and the analogous provisions of the relevant statutes in the United Kingdom with the objective of making recommendations to develop the existing law in Sri Lanka.

**Keywords** - used goods, merchantable quality, sale of goods

## I. INTRODUCTION

S.15 (2) of the SGO of 1896 specifies that 'where goods are bought by description from a seller who deals in goods of that description, there is an implied condition that the goods shall be of merchantable quality; provided that if the buyer has examined the goods there shall be no implied

condition as regards defects which such examination ought to have revealed'. Further, it is laid down by the S. 16 (2) (c) that 'there is an implied condition that the goods shall be free from any defect rendering them unmerchantable, which would not be apparent on reasonable examination of the sample'.

SGO of 1896 does not provide a definition regarding 'merchantability' and hence judges are left with the only option of referring to precedence on the matter. The SGO of 1896 has heavily drawn from the Sale of Goods Act 1893 (SGA of 1893) of the United Kingdom which was later replaced by the Sale of Goods Act of 1979 (SGA of 1979).

## II. METHODOLOGY

This doctrinal research was conducted based on the traditional black letter approach. The relevant statutory provisions and case law are critically analysed. Qualitative data was collected through a review of primary sources; national and foreign legislation, case law and secondary sources; books with critical analysis, law journals and conference papers.

The scope of this research is limited to an analysis of the applicability of the implied condition of 'merchantable quality' to used goods and to a brief discourse on related legal issues. Further, the comparative analysis method is used to examine difference between the statutory provisions in the SGO of 1896 regarding 'merchantable quality' and the analogous provisions of the relevant statutes in the United Kingdom with the objective of making recommendations to develop the existing law in Sri Lanka.

Lack of availability of Sri Lankan case law and scholarly work in relation to the SGO of 1896, operated as the main restriction for furtherance of this research.

### III. DISCUSSION AND ANALYSIS

#### A. INTERPRETING 'MERCHANTABLE QUALITY'.

Schedule 01 to the SGA of 1979 provides a definition to the term 'merchantable quality' as "... fit for the purpose or purposes for which goods of that kind are commonly bought as it is reasonable to expect having regard to any description applied to them, the price (if relevant) and all the other relevant circumstances.". Yet, the SGO of 1896 fails to interpret this term.

However, it should be noted that in 1979 the United Kingdom Law Commission Report on Law of Contract (Law Co 95) stated that the term 'merchantable quality' should be reviewed. Later it was substituted by the term 'satisfactory quality' in 1995 by an amendment made to the Act and has been in effect for over two decades even though Sri Lanka still retains the old term 'merchantable quality'.

Hence, for the purpose of interpreting 'merchantable quality', Sri Lankan judiciary is compelled to make reference to the old regime of English case law, decided prior to the amendment in 1979 which introduced the term 'satisfactory quality'.

In *G. W. P. Gunawardena v Ceylon Steel Corporation Oruwala* (2011) Gooneratne J. made reference to Lord Reid in *B.S. Brown & Sons Ltd. V. Craiks Ltd.* (1970). In the latter case, Subject matter of the sale of goods contract was industrial fabric and when sold, it was found to be unsuitable to stitch dresses although it could be used for other industrial purposes.

The issue raised was whether the goods were of 'merchantable quality' to which the House of Lords responded in the affirmative. It had been held that goods were not of merchantable quality if "... the goods in the form in which they were tendered were of no use for any purpose for which goods which complied with the description under which these goods were sold would normally be used, and hence were not saleable under that description". In this case, since the goods had commercial value and it could be used for some other commercial purpose, they were held to meet the demand

for 'merchantable quality'. On the other hand, if the goods could not be used for any purpose for which the goods of the same description were usually used, and they could not be resold for the same or a suitable price as if they were suited for every purpose, the goods would not have been held to be of 'merchantable quality'.

Further, it was stated that the fact that the defective condition is easily removable, for instance an irritant can be washed away out of the clothes, is immaterial when assessing the desired level of quality.

Accordingly, goods do not qualify to be of merchantable quality if, in the condition in which they are tendered

- (1) they have defects unfitting them for their ordinary use, or
- (2) their condition is such that no reasonable buyer, with knowledge of their true condition, would accept them in performance of the contract.

Further, in *D. M. S. Office Products Ltd v D. Manikkam* (2012), reference has been made to *Summer, Permain & Co. v. Webb & Co.* (1922) where it had been emphasized that the goods will not be rendered 'unmerchantable' merely because the sale of those goods are illegal under a law of a foreign State.

However, as correctly pointed out by Lord Reid in *B.S. Brown & Sons Ltd. V. Craiks Ltd.* (1970), "...judicial observation can never be regarded as complete definitions,; they must be read in light of the facts and issues raised in the particular case. ". He further emphasized that "it is not possible to frame, except in the vaguest terms, a definition of "merchantable quality" which can apply to every kind of case".

#### B. MERCHANTABLE QUALITY AND USED GOODS

It is clear from any doubts that this condition of 'merchantable quality', would award protection to a buyer who purchases goods in the usual way from a shop. In *David Jones v. Willis* (1934) cases, the plaintiff has purchased a pair of shoes from the defendant. The defendant was only the retailer distributor of the shoes and not the manufacturer.

The plaintiff wore shoes for two times and on the third occasion, the heel came off causing him to fall over and get injured. Plaintiff sued the defendant to claim damages and the court decided that there was a breach of the condition

of 'merchantable quality' and the shoes did not fit for the purpose.

However, the question to be addressed in this context is whether a buyer buying the second hand goods are entitled to the same level protection by the SGO of 1896 as received by a buyer of a brand new product. Further, it is necessary to inquire whether it is fair to expect a seller of used goods to offer the same level of quality as offered by a seller of brand new products.

Firstly, when considered from the buyers' side it should be emphasized that protection will be provided by the S. 15 (2) and 16 (2) if one buys a second hand product from a seller who deals in goods of that description. For instance, if the buyer buys a second hand bicycle on ebay from an official company dealing with the bicycles, the product should fit for the purpose and breaching this condition would give rise to the right to repudiate the contract. Further, the implied condition of merchantability is applicable, and the buyer exercises related rights, if the he or she buys goods from a second-hand shop, irrespective of whether the shop manufactures the products of not.

In *Crowther v Shannon Motor Co* (1975), a car was purchased for £950 and was driven 2,500 miles before the engine ceased up. The Court of Appeal held that the defect could not be reasonably anticipated for a car of this age and mileage, and there was a breach of merchantable quality.

Nevertheless, most of the time, second hand goods are sold by private individuals. It is a usual practice to sell items such as furniture, books or even machinery when those had been used for some time. In that context, such sellers will not fall within the meaning of 'a seller who deals in goods of that description' and hence buyers who deal with them will not get the protection provided by the implied condition as mentioned in the SGO of 1896.

If one is purchasing second hand goods from a private seller, then the only conditions relating to the title and description will be applicable. Accordingly, the seller should have a proper title to the goods he is selling and the goods should be free from any charge of encumbrances in favour of any third party, not declared or known to the buyer before or at the time the contract was made. Further, it is required that the goods when sold by description, should comply with the description although there is no condition applicable with regard to quality.

Therefore, if one buys a used designer dress of which the

material was described as Velvet, the material cannot be Cotton.

However, the SGO of 1896 will not provide any protection if the fabric has a lesser quality than what the buyer expected. Hence it is important to keep in mind the doctrine of *Caveat Emptor*, i.e., 'let the buyer beware', since where the transaction is informal, the risk will have to be borne by the buyer.

Further, it is important to emphasize that legal rights against lack of merchantable quality will not be available when the buyer has seen the goods before he purchases it and the complaint surrounds a defect which would have been revealed by a reasonable examination. As decided in *Thornett v Beers & Son* (1919), fact that the buyer did not engage in such an inspection is immaterial as long as he has had a reasonable opportunity to check the goods. Hence, even in an auction sale, if the buyer goes there in person and buys goods, complaints made afterwards regarding the quality of the goods will not be entertained.

### C. ASSESSMENT OF MERCHANTABLE QUALITY

In the United Kingdom even under the SGA of 1893, some guidance to assess merchantable quality had been provided stating that "... any description applied to them, the price (if relevant) and all the other relevant circumstances..." should be taken into account when assessing 'merchantable quality'. Nevertheless, in Sri Lanka, the SGO of 1896 leaves the parties to a sale of goods contract in dark with its failure to provide any guidelines.

Moving further from SGA of 1979, S. 14 of the SGA of 1979 in the United Kingdom which specifies implied terms about quality and fitness, in addition to replacing the term 'merchantable quality' with 'satisfactory quality', provides an objective yardstick to measure the 'satisfactory quality'. S. 14 (2A) states 'For the purposes of this Act, goods are of satisfactory quality if they meet the standard that a reasonable person would regard as satisfactory, taking account of any description of the goods, the price (if relevant) and all the other relevant circumstances.'

Moreover, S. 14 (2B) states that quality of the goods include their state and condition and specifies certain other factors viz. fitness for all the purposes for which goods of the kind in question are commonly supplied, appearance and finish, freedom from minor defects, safety, and durability, to be



considered, inter alia, as aspects of quality in appropriate cases. It is noteworthy that these guidelines can be utilized by judges to evaluate the quality of goods regardless of whether the goods are new or second hand.

#### **D. DISTINGUISHING THE STANDARD OF QUALITY EXPECTED FROM NEW AND USED GOODS.**

In *Bartlett v Sidney Marcus* (1965), in which the claimant purchased a second hand jaguar for £950 from a car dealer, having been told that the clutch needed a small repair. However, when the car had done 300 miles, the claimant found out that the condition of the clutch was far graver than what he expected and it required a completely new clutch costing £84. Although, in the first instance of litigation, the judges decided that the clutch was not merchantable, in the appeal car dealers were successful. The car was held to be of merchantable quality as the defect was the kind that could be anticipated in a second hand car.

Lord Denning in *Bartlett v Sidney Marcus* (1965) stated “A second-hand car is ‘reasonably fit for the purpose’ if it is in roadworthy condition, fit to be driven along the road in safety, even though not as perfect as a new car. Applying those tests here, the car was far from perfect. It required a good deal of work to be done on it. But so do many second-hand cars. A buyer should realise that when he buys a second-hand car, defects may appear sooner or later; and, in the absence of an express warranty, he has no redress.”

In the context of the SGO of 1896, if goods are bought from a dealer of second hand goods (not from a private seller) then it is seller’s responsibility to make sure that the goods are of merchantable quality. However, this requirement cannot held to be justifiable since the Ordinance does not make any distinction between used and unused goods when applying this condition with regard to goods that are bought by description from a seller who deals in goods of that description.

It is obvious that, when goods are described as ‘second hand’ or ‘used’, a reasonable person will not expect the same level of quality as expected from a brand new unused product. In almost all circumstances, second hand goods are sold for a lesser price than the new products and, when considering the quality of the goods, the price paid should also be considered as specified by SGA of 1979. Absence of such a standard in the SGO of 1896 makes the transactions between buyers and sellers confusing.

## **IV. CONCLUSION AND RECOMMENDATIONS**

Absence of a definition for the term ‘merchantable quality’ in SGO of 1896, makes the transactions between buyers and sellers complicated. Further, the Ordinance does not specify the relevant factors that should be taken into account when assessing the ‘merchantable quality’ and hence, particularly in cases regarding sales of used items, this lacuna can bring injustice.

It is submitted that the SGO of 1896 should provide guidelines as provided by the SGA of 1979 to measure the specified quality, irrespective of whether the goods are new or second hand. Such a reform can bring forth consistency as it will prevent the judges, to a greater extent, from deciding cases based on their individual opinion of quality and usage of different standards in similar cases.

Moreover, it is noteworthy, that the existing term of ‘merchantable quality’ as pointed out correctly by the United Kingdom Law Commission Report on the Sale and Supply of Goods, with regard to the SGA of 1893, reflects the 19th century trade and concepts of law. Hence, it is finally submitted that it is high time for the SGO of 1896 to replace the archaic term of ‘merchantable quality’ with the term ‘satisfactory quality’ following the example provided by the SGA of 1979.

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# FINANCIAL TRANSACTIONS REPORTING: AN OVERVIEW OF THE SRI LANKAN LAW

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**Abstract** - Financial crimes including money laundering and terrorist financing has become a major burden to the economies of almost all the jurisdictions. Further, the institutions engaged in finance business including banking business are the most exposed institutions to financial crimes as they are doing their business with money which is the most liquid asset. In Sri Lanka, three major legislations namely, Convention on the Suppression of Terrorist Financing Act No 25 of 2005, Prevention of Money Laundering Act No 5 of 2006 and Financial Transactions Reporting Act No 6 of 2006 (FTRA) had been enacted targeting countering such financial crimes. However, FTRA can be identified as the enactment which influences the most in the sense of banking and finance business as it has introduced important guidelines and instructions for the institutions, while setting up the Financial Intelligence Unit. Hence, this paper will discuss the main features of FTRA and its consequence to the institutions engaged in finance business including the snags face in implementing the act. The author uses primary sources viz. acts, codes and guidelines and secondary sources viz. journals, reports, annual reports, electronic resources and books as main sources for this study. Finally, the paper concludes with suggestions to FTRA towards strengthening the legal regime to combat against money laundering and terrorist financing while minimizing afflictions affecting the institutions in complying with FTRA.

**Keywords** - Money Laundering, Terrorist Financing, Financial Transactions Reporting, Sri Lanka

## I. INTRODUCTION

Financial Services regulations are mainly created for the purpose of monitoring the organizations to protect their depositors. Those regulations can be identified not only in the form of statutory and administrative provisions but

also in the form of informal regulations of norms. Mostly in the developing countries, those informal regulations such as using government discretion to influence the functioning of the financial sector institutions, outside the statutory provisions can be seen. In any regulatory framework, there can be identified requirements, guidelines and restrictions aiming for the smooth functioning and safety of the financial system. Financial sector policies and regulations are mainly for ensuring safety and soundness of the financial system, supervision, regulation, depositor/consumer protection, ensuring and enhancing financial inclusion and supply of adequate credit to economically important sectors. Nevertheless, the regulatory authorities of different jurisdictions introduce these objectives in their own formats. As an example, the Financial Services and Markets Act 2000 of United Kingdom, specifies four main objectives which are market confidence, public awareness, consumer protection and reduction of financial crimes. Accordingly, every regulatory authority has adopted regulations in accordance with their objectives.

With the past experiences and future requirements, Sri Lanka also enacted several laws which are more important for the financial sector and among such legislations, there are three main pieces of legislations covering Sri Lanka's regime of anti-money laundering and combatting terrorist financing. Those legislations are;

1. Convention on the Suppression of Terrorist Financing Act, No. 25 of 2005 (CSTFA)
2. Prevention of Money Laundering Act, No. 05 of 2006 (PMLA)
3. Financial Transaction Reporting Act, No. 06 of 2006 (FTRA)

The FTRA, which is the most invasive of above three legislations in terms of the Banking and Finance business, has introduced important guidelines and instructions for

the institutions, while setting up the Financial Intelligence Unit (FIU). It opens array to facilitate the prevention, detection, investigation and prosecution of the offences related with money laundering and terrorist financing by collecting data on suspicious financial transactions.

After the 9/11 attack on USA in 2001, the Financial Action Task Force (FATF), which is the inter-governmental body established in 1989 to set standards to effectively implement legal and regulatory measures related to money laundering activities, expanded their scope by adding 09 recommendations to the existing 40 recommendations covering the combatting against terrorist financing. According to FATF , their recommendations are considered as important measures to;

1. identify the risks, and develop policies and domestic coordination
2. pursue money laundering, terrorist financing and the financing of proliferation
3. apply preventive measures for the financial sector and other designated sectors
4. establish powers and responsibilities for the competent authorities and other institutional measures
5. enhance the transparency and availability of beneficial ownership information of legal persons and arrangements
6. facilitate international cooperation

Accordingly, the countries have implemented measures including laws, regulations, guidelines, etc. with the intention of combatting money laundering and terrorist financing while complying the FATF recommendations. Three legislations mentioned above which were enacted in 2005 and 2006 are the outcome of that recommendations in Sri Lanka.

Sri Lanka experienced a thirty year long war which resulted a massive damage to the economy and lifestyle of the people. Almost all the people were affected directly or indirectly. Sri Lanka felt the harshness of the terrorism decades before the 9/11 incident which opened the eyes of European community. Further, not only because of the terrorism, but also of the money laundering activities, the country has faced troubles in the history. Lessons were learnt form the illegal deposit collectors, who was

identified as Ponzi Scam operators such as Sakwithi Ranasinghe , Piyadasa Rathnayake alias “Danduam Mudalali ” who offered around 90% annual interest rate and copycat financiers such as Saman Udayanga alias “Dadi Danduam” (great punishment) as direct and indirect consequences of money laundering which vanished even hard-earned money of some innocent individuals.

Although, the war ended in mid-2009, the risk of terrorist financing and money laundering is still there. Some may think that the FTRA and other related enactments are not important as there is no war situation within the country , but, it is not the case. Terrorist financing and money laundering are global issues. Hence, global and regional measures should be implemented in combatting against such crimes and legal regime should be further strengthened. This is the reason behind the recent amendment to the laws according to international obligations to United National regulations to confrontation with the criminals . Further, while emerging the economic activities after the war, the tendency of financial crimes also increasing accordingly. Therefore, financial transaction reporting is still important in the sense of banking and finance business, which is a highly opened sector to such crimes and are aimed by the criminals to use intentionally or unintentionally to their crime channels.

## II. OBJECTIVES

Financial Transaction Reporting is not only a responsibility of the financial institutions. Even the general public has a responsibility in terms of combatting terrorism and financial crimes. As per the provisions the institutions shall conduct ongoing due diligence on the business relationship with its customers . To conduct such ongoing due diligence process the general public is required to have a better understanding on the laws. Even the provisions of the FTRA, protects the institutions, auditors, supervisory authorities, directors, partners, officers, employees, agents from civil, criminal or disciplinary proceedings in relation to any act carried out in good faith under the provisions of the act . However, it is questionable whether the general public is well aware on the provisions of this act, how it works and the objectives of the provisions. Even some individuals who required to perform according to the provisions and who are responsible in combatting money laundering and terrorist financing are not well aware on the provisions and the objectives of such provisions.

In view of that, this research will survey the existing legal

framework in Sri Lanka related to financial transactions reporting while drawing some examples from other jurisdictions. While discussing the responsibilities of the related parties, the research will draw attention of the lawmakers on recommendations to develop and further strengthen the laws. Further, this will fill the gap on researches related to this area.

### III. METHODOLOGY

The study is a qualitative study. Since it is mainly focused on the laws relating to the financial transactions reporting, the FTRA and other relevant legislations and the regulators' guidelines were used as primary sources. By examining the primary sources, the author demonstrates the existing law related to financial transactions reporting and its significances to the financial sector in Sri Lanka. The FTRA influenced the financial sector by setting up the regulations for transactions reporting while establishing the FIU. Such primary sources were used to identify the obligations of the stakeholders while identifying the role of the FIU. Secondly, the author focused on Annual Reports of the Banks and other Financial Institutions, procedure manuals of some commercial banks, Annual Reports of the FIU, research papers of local and international scholars on the relevant fields and other printed and electronic sources as secondary sources. The statistics on the financial transaction reporting were gathered from the annual reports of the FIU and the annual reports of other banks were examined to identify the measures taken by them to comply with the relevant laws and regulations. In addition, information related to complying the measures were gathered from examining the procedure manuals of some commercial banks. Further, articles, research papers and other printed and electronic documents were used to identify the scenario and make recommendations in order to further strengthening the legal regime of financial transaction can report any suspicion towards combatting money laundering and terrorist financing .

### IV. ANALYSIS

#### A. Background

The financial reporting of Sri Lanka is governed by the FTRA which was enacted in 2006. It is an act to provide for the collection of data relating to suspicious financial transactions to facilitate the prevention, detection, investigation and prosecution of the offences of money laundering and the finance of terrorism respectively; to

require certain institutions to undertake due diligence measures to combat money laundering and the financing of terrorism; to identify the authority which will be responsible for monitoring the activities of all institutions to whom this act applies; and to provide for matters connected therewith or incidental thereto .

The United Nations Security Council by the resolution (UNSCR) No 1267 (1999) has decided to require all the countries to "Freeze funds and other financial resources, including funds derived or generated from property owned or controlled directly or indirectly by the Taliban, or by any undertaking owned or controlled by the Taliban, as designated by the Committee established by paragraph 6 below, and ensure that neither they nor any other funds or financial resources so designated are made available, by their nationals or by any persons within their territory, to or for the benefit of the Taliban or any undertaking owned or controlled, directly or indirectly, by the Taliban, except as may be authorized by the Committee on a case-by-case basis on the grounds of humanitarian need" . This measure was mainly targeted Usama Bin Laden. However, this resolution No 1267 with its successors requires the institutions to take measures to identify and freeze funds immediately. This resolution was implemented in Sri Lanka in 2012 . Further, with the UNSCR 1373 (2001) which was also implemented in Sri Lanka in 2012 , the countries were required to identify and freeze funds and financial assets of the designate individuals and entities . It further requires the states to take measure including to refrain from providing any form of support, active or passive, to entities or persons involved in terrorist acts, including by suppressing recruitment of members of terrorist groups and eliminating the supply of weapons to terrorists, take the necessary steps to prevent the commission of terrorist acts, including by provision of early warning to other states by exchange of information and deny safe haven to those who finance, plan, support, or commit terrorist acts, or provide safe havens .

#### B. Financial Intelligence Unit

Accordingly, the FIU was established in 2006 under the Ministry of Finance and Planning and since February 2007, it operates as a department of the Central Bank of Sri Lanka, which is the regulatory authority of the Banking and Finance sector with the objective of combatting money laundering, terrorist financing and other related financial crimes in Sri Lanka in line with international recommendations and standards . The FIU receives Cash Transactions Reports (CTR), Electronic Fund Transfers

(EFT) and Suspicious Transactions Reports (STR) from the reporting institutions which includes licensed banks, finance companies, stock brokers, insurance companies and money changers. Further the law enforcement agencies, supervisory authorities and general public also can report to the FIU. In terms of the FTRA, the institutions shall report any transaction which exceed the sum which is prescribed by the minister or its equivalent in any foreign currency and any electronic fund transfer exceeding such sum . The sum has been prescribed by the minister as one million rupees at present as per the extraordinary gazette no 1555/9 of 25.06.2008. Further, the institutions shall report to the FIU any transaction or attempted transaction which is suspicious or may relate to any unlawful or criminal activity and if the institution has information that it suspects may be relevant to an act preparatory to an offence under CSTFA or to an investigation or prosecution under PMLA or CSTFA . In this purpose the institutions or the responsible individuals can report any suspicious transactions despite of the value of the transaction and there is no monetary threshold for reporting such suspicious transactions.

Accordingly, CTRs, EFTs and STRs received by FIU from 2011 to 2015 as follows;

**Table 1: Receipt of Reports to FIU under FTRA**

	2011	2012	2013	2014	2015
CTRs	3,182,254	3,420,819	3,139,919	3,214,613	3,034,243
EFTs	698,659	796,836	1,483,445	2,712,393	3,056,182
STRs	185	203	366	718	783
Total	3,881,098	4,217,858	4,623,730	5,927,724	6,091,208

*Source: FIU – Sri Lanka*

Since, the financial system of the country is moving toward the electronic forms , the number of EFTs have exceeded the number of CFTs in 2015 where the number of EFTs are lower than the CFTs in previous years.

Other functions which are authorized by the FTRA include maintaining the information in a database, analyzing and assessing the information, requesting information and carrying out examination . Further, the FIU also may disclose any report or information to foreign or international agency that is similar to FIU and it has the power to enter in to the arrangements and agreements in the form of Memorandum of Understandings (MOU) with third parties . Accordingly, it has already entered into

MOUs with 32 jurisdictions and domestic government agencies such as Sri Lanka Customs, Department of Immigration and Emigration, Department of Inland Revenue and Department of Registration of Persons to facilitate the exchange of information. Further, Sri Lanka has the membership of international corporations which are Asia Pacific Group on Money Laundering and Egmont Group. Since the process of combatting against the money laundering and terrorist financing is cannot be done individually, such arrangements under the provisions of the act is strengthening the structure by increasing the fruitfulness of reporting the financial transactions.

**C. Responsibility of the Institutions**

Every institution shall appoint a compliance officer to ensure the institution’s compliance with the FTRA . Accordingly, compliance officers were appointed by the institutions including the banks from a key management position and such officers are directly report to the top management. In addition the institutions are required to establish and maintain procedures and systems to implement the requirements of the FTRA , including implementing the customer identification requirements, procedures for the record keeping and retention requirements, process of monitoring and the reporting requirements and make the officers of such institutions aware of the laws related to money laundering and terrorist financing while screening all the persons before hiring as employees . The Compliance officer is responsible to ensure such procedures and systems within the institution. Accordingly, most of the institutions have adopted the requirements of the FTRA to their risk management structure. As an example, the Bank of Ceylon has automated the anti-money laundering and combatting terrorist finance activities by launching financial crime detection system named “AMLock” in 2014 . Further, the People’s Bank also developed systems and procedures to give the fullest support to combat money laundering and terrorist financing while training its employees and developing E-learning modules . Not only government banks but also private reporting institutions have also developed automated systems for the reporting and monitoring purposes . DFCC Vardhana Bank has developed such system with the network comprise of branch and department level users which were supervised by Compliance Department. This system monitors the transaction centrally targeting anti money laundering and preventing terrorist financing activities. Domestic politically exposed persons lists, international specially designated nationals lists such as United Nations and Office of Foreign Asset Controls have been incorporated to the system to closely monitor such individuals.

It is required to mention that this legislation is not only applicable to the banking institutions and other financial institutions. In this act “institution” means any person or body of persons engaged in or carrying out any finance business or designated non-finance business . Even the professionals including lawyers, notaries, other independent legal professionals and accountants when they prepare for or carry out transactions for their clients in relation to buying and selling of real estate, managing of client money, securities or other assets, management of bank, savings or securities accounts, organization of contributions for the creation, operation or management of companies and creation, operation or management of legal person or arrangements and the buying and selling of business entities are included within the definition of designated non-finance business . Such individuals and professionals are commonly used in the money laundering process. Kiritharan states that professionals who are struggling with financial difficulties can easily be targeted by the money launders and further laundering can be done using the clients or their accounts.

#### D. Examples from other Jurisdictions

The prevention of Money Laundering Act, 2002, No. 15 of 2003 of India governs this area and the reporting authority is the FIU-India which is under the ministry of Finance of India. The threshold limit of India is rupees ten lakhs and all the suspicious transactions should be reported. Laws related to financial transactions reporting has been introduced to the Bahamas in 2000 and suspicious transactions and cash transactions exceed the threshold should be reported to the FIU. According to the Anti-Money Laundering Act of 2010 the threshold limit in Pakistan is rupees two million and such transactions and suspicious transactions should be reported to the Financial Monitoring Unit. The Maldives Financial Transaction Reporting Regulations were introduced and came in to the operation in 2011 and a financial intelligence unit has also been established subsequently.

## V. RECOMMENDATIONS

The main regulation governs the financial transactions reporting in Sri Lanka is the FTRA, other than the guidelines and circulars issued by the regulator in accordance with the prevailing provisions. The law is mainly focused on combatting money laundering and terrorist financing activities not only locally but also globally. Know your Customer (KYC) and Customer

Due Diligence (CDD) measures are very important for the employees of the reporting institutions for proper reporting. Every employee should be given a proper training on KYC and CDD rules and they should be educated on the idea of such measures. Further, such employees should know the ultimate objective of the reporting. Statistics shows that the reports on money laundering is increasing in the post war era. Welcoming the inflows of the investments is creating a heaven for money launders . So, strengthening the combatting methods is essential. Such trainings will play a vital role in reporting and combatting. Institutional trainings should be encouraged while conducting training programs for institutions in relation to customer identification, record keeping and reporting obligations and the identifications of suspicious transactions as pre the FTRA . In addition, process and procedures should be implemented to train the institutions, professional and individuals who are engaged in designated non-financial business. Areas such as laws related to Anti-money laundering, combatting terrorist financing and financial transactions reporting should be included in the curriculums for law students, students who learn banking and finance and the students.

Further, the information collected should be kept up to date. It is necessary to identify the unusual transactions which is done even by the usual customers as they may be used by third parties to achieve their targets.

Some of the employees may be in doubt, whether the requirements of the FTRA contradict with the bank secrecy. But, the FTRA itself gives provisions to protect the persons who report the suspicious transactions. No civil, criminal or even disciplinary proceedings can be instituted against the persons who reports the transactions including such institutions, auditors, supervisory authorities, directors, partners, officers or employees .

And most importantly, the general public has to be informed and educated on this reporting structure and the provisions of FTRA. Most of them do not like to fill different forms with range of information because of the unawareness on the law and the objectives of such information collections. Therefore, the general public has to be educated through printed media, electronic media and social media to impress them that the actions are for the safety of their own money and the economy of the country.

Further, the technology which is used to report including the “LankaFin” which is the in-house built database

management system of the FIU, has to be continuously developed with the necessary security features and with collaboration with other countries with in the region. In addition the reporting institutions also should be

instructed and facilitated to maintain proper developed information systems to identify and report the suspicious transactions.

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## VI. CONCLUSION

FTRA, No. 6 of 2006 is one of the three main legislations related to anti-money laundering and combatting terrorist financing in Sri Lanka. This comparatively new legislation which enacted in 2006 is mainly based on the recommendations of the FATF. The main institution established under this enactment which is FIU is performing a significant role in this regard. With the nature of the requirements, such laws has to be developed continuously. Criminals do not use the same methods of doing crimes. Accordingly, with the global cooperation, well strengthened framework should be continuously ensured. However, the FTRA can be identified as an enactment which is providing a well-established platform in preventing money laundering and terrorist financing through proper reporting of financial transactions.

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# TAX AMNESTIES: THE CASE OF STICKS AND CARROTS

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**Abstract** - Tax amnesties are an invitation to tax evaders to join the ranks of people who pay the due taxes. The popularity of amnesty programs over time and across countries is understandable as it produces both short- and medium-term benefits. However, cost benefit analysis shows that the costs exceed the benefits of the program. This paper weighs the advantages and disadvantages of tax amnesties, drawing on results from the theoretical literature, econometric evidence, and using Sri Lanka as a case study. The focal point of this research is to determine if a 'successful' tax amnesty is a norm or an exception to the norm. It is evident that tax amnesties have been devised to increase tax compliance. However, the low levels of tax compliance can be better addressed via improvements to the tax administration system. Thus, it leads to the question whether tax amnesties are only a plaster on a broken bone where an extensive surgery is required for full reparation i.e. an enhanced tax administration system. It must be understood that tax amnesties alone cannot increase tax compliance, as it is only an incentivizing mechanism and not the solution to the larger problem at hand. Most successful amnesty programs rely on improving the tax administration's enforcement capacity. Furthermore, given the potential drawbacks of tax amnesties, a few alternative measures are discussed which can be implemented to improve the enforcement capacity of tax administration system.

**Keywords** - Tax Amnesty, Tax Administration, Compliance, Evasion

## I. INTRODUCTION

A tax amnesty provides a time bound window of opportunity for taxpayers to pay a defined amount, in

exchange for forgiveness. The tax liability payable for the past tax period(s) including interest and penalties will be overlooked by a tax amnesty. A tax evader who makes use of an amnesty will not be criminally prosecuted for his past mistakes.

The American Bar Association in 1987 describes tax compliance to be the 'payment of taxes as required by the legislation' and 'the timely filling and reporting of required tax information, the correct self-assessment of the taxes... owed and the timely payment of those taxes without enforcement action'.

Process of compliance must ensure identification of taxpayers, assessment and collection of taxes due from them.

Tax compliance, simply put, is the extent to which a taxpayer agrees (or disagrees) with the tax rules of his country. Accordingly, a rise or fall in tax compliance refers to the number of taxpayers paying the due taxes, producing and submitting information to the tax authorities on time correctly in a given tax year. The mere submission of returns does not cater to all aspects of the elaborate definition(s) on tax compliance.

Reluctance to pay taxes has been observed worldwide amongst taxpayers. Direct taxes such as income tax and even indirect taxes on consumption such as Value Added Tax (VAT), Goods and Services Tax (GST) and other sales taxes are usually paid late often past their due dates. Delay in payments of course is when remittance to tax authorities is entirely unavoidable. The culture of reluctance is often due to reduction in resources and economic vigour i.e. taxes may take a sizeable cut off a person's income. This feeling of a taxpayer is usually influenced by socioeconomic and

political factors present within the country. The aggregate effect of this rather global phenomenon is usually reflected in declining rates of compliance.

The causal nexus between amnesties and tax compliance has quite a roundabout way of unravelling itself. Theoretically, a tax amnesty by operation must increase tax compliance by enabling ex tax evaders to join the ranks of tax payers. However, in practise, this does not appear to be the case.

## II. VITALITY OF TAX COMPLIANCE FOR TAX SYSTEMS AND TAX ADMINISTRATION

'Tax on income became a reality because of the concern of the government...that public expenditure should not exceed revenue.' (Gooneratne, 1992)

Any government in the world must generate revenue to fund itself. On the other side of the equation, a major share of government revenue is usually earned via taxes. In Sri Lanka, during the period of 2000, 2001 and 2002 tax revenue as a percentage of total government revenue was at 86%, 88% and 85% respectively.<sup>1</sup> (Note -For the purpose of this study, the period from 2000-2003 have been examined as a tax amnesty was last operated in Sri Lanka in 2003)

### A. Tax administration

Bagchi, Bird and Das Gupta (1994) points out that the primary function of tax administration is to monitor compliance and apply sanctions (or otherwise) as prescribed in the statute against the offenders. Compliance also effects other preliminary functions of tax administration i.e. assessment and collection. Unsatisfactory compliance can cause delays and loss of momentum which in turn can jeopardize the whole tax system. However, achievement of overall compliance up to a greater percentage of all taxpayers makes a tax system very successful. A successful tax system paves way to implementation of tax policies by the tax administration. Thus, compliance is a vital requirement for tax administration as well as a tax system.

Compliance may vary from country to country, time to time and even amongst taxes depending on the context. Effectiveness of efforts by tax administration to enforce compliance and economic growth are the main factors affecting compliance.

According to Bahl and Bird low tax morale, unskilled and underpaid workforce, manual and outdated procedures are the attributes of poor tax administration. They attributed slow revenue growth not only to slow economic growth but also to narrow tax base and inefficient administration. Moreover, their position may be summarized by what they said in their research paper, "No tax is better than its administration, so tax administration matters -- a lot." (Asgar, n.d.)

### B. The Sri Lankan experience

Non-compliance and lack of compliance, like a troublesome pair of non-identical twins, has wreaked havoc in the tax system time to time. The disease did not only plague the tax system but also affected the economic climate of the country when the government revenue dropped and debts sky rocketed.

Prosecuting and imposition of penalties on offenders, specifically on those who do not submit annual returns have been widely used to curb the problem of non-compliance in Sri Lanka. The other measures used to enhance compliance include auditing and investigations (In Denmark compliance rate is 95% due to effective audit (Asgar, n.d.)) collection of tax at source as in the case of Withholding Tax (WHT), use of information, field surveys and maintenance of taxpayer assistance centres etc.

During the last 50 years or so, a number of tax amnesties were introduced to the Sri Lankan tax system to enhance future compliance. Although repetitive enforcement of tax amnesties are not recommended, some countries have an unhealthy addiction towards the same i.e. declaring repeated amnesties. Sri Lanka too have employed 10 tax amnesties from 1964 to 2003. (Hapuarachchi, 2005) Under most amnesties, pardon is granted only for penalty amounts. Prosecution and investigation rights of the tax authorities are not exercised against those declarants. In Sri Lanka, collecting tax amounts due by employing amnesties is a rare occurrence since only an increase in levels of compliance was expected in most instances. In

<sup>1</sup> As per Administration Reports of Commissioner General of Inland Revenue (CGIR)

<sup>2</sup> Repeated amnesties were also implemented in Argentina, Chile, Bolivia, Peru, Mexico, India, Pakistan and Philippines.

all recent amnesties employed, full immunity have been granted where no back taxes were collected.

The amnesty of 2003 which brought the highest recorded number of declarations under an amnesty provided in Sri Lanka provided forgiveness and exoneration from all dues on all taxes concerned. Additionally, non-implementation of investigation and prosecution provisions of the tax statute was also guaranteed. The amnesty of 2003 is seen to be the 'most peculiar and beneficial' amnesty so far introduced in the history of amnesties as it provided protection from 26 statutes operating to raise government revenue in Sri Lanka via both direct and indirect taxes. (Hapuarachchi, 2005)

### C. Purpose and objectives of this study

Tax amnesties are normally used as the last resort to enhance compliance. Although, a number of amnesties were declared with the hope that tax evaders will be captured by the tax system without the fear of being penalised, authorities believe that the potential tax revenue does not flow to the government coffers. Although the per capita GDP have been gradually increasing over decades, a wide disparity in income distribution prevails.

Then the number of taxpayers should increase since majority of the income is earned by a section of the public which should be more than the existing number of taxpayers. However, the number of individual tax payers have always been less than 1% of the total population. Even in the existing tax files it is doubtful where correct amounts of taxes are being assessed. The ultimate consequence is always loss of government revenue.

In such a background, government seems to rely on tax amnesties as a tool to increase income tax compliance. Attraction towards tax amnesties are mainly because it generates short term revenue.

However, adequate studies have not been carried out to determine the effectiveness of tax amnesties on income tax compliance.

This study aims to establish effects of amnesties on income tax compliance within the status quo of the tax system and administration in Sri Lanka i.e. how an amnesty can affect the compliance trend.

## III. TAX AMNESTIES FOR COMPLIANCE ENFORCEMENT

In an ideal setting, firstly, a tax amnesty is an opportunity to pay previously unpaid taxes sans penalties. In some instances such taxes may be written off and/or disregarded completely when compliance is the primary motive of the amnesty in effect. An amnesty also provides the guarantee of non-prosecution and investigation, a sovereign act of forgiveness by a government to all citizens – which doubles the attractiveness of an amnesty.

Secondly, an amnesty is introduced to improve short term gains which can also be experienced in the long run when the new declarants files tax returns.

However, theoretical and empirical work on this area of study suggests otherwise revealing controversies on reaching objectives of tax amnesties.

### A. Tax amnesties and money laundering

The sudden commercial boom worldwide has much to do with globalization. The evolving nature of business activities drove some of them underground far from the prying eyes of any authority. Immoral and/or illegal underground activities and even a portion of legitimate economic activities may be purposely hidden (i.e. not visible and taxable) via evasion, avoidance and tax planning. The only way to bring the untaxed income to the economy for routine circulation would be to coax them out of their hiding spots. A rational thinker may consider the auxiliary benefits of a tax amnesty and calculate how a tax amnesty fills the void in laundering black money.

An amnesty is an opportunity to declare such past income without paying taxes and enjoying immunity from punitive measures applicable against the offence of tax evasion.

For an instance, in an interview with tax advisors, it was revealed that 'high wealth individuals' in Australia who have accumulated non taxed income overseas by operating in tax havens were expecting an amnesty to declare their assets. (Braithwaite, 2003)

### B. Objectives of 'declaring' a tax amnesty

The economic objective of declaring a tax amnesty is to contribute to the development of the country by increasing money in circulation and capital reserves. Introducing the

large wealth amassed but not declared or invested in the formal economy of the country into the formal economy is an amnesties way of contributing a country's development. From the tax administration's point of view, compliance and revenue enhancing tools such as tax amnesties are strategic measures adopted to bring tax evaders into the tax net voluntarily thereby enabling tax revenue to reach its potentiality. For this purpose, 'carrots' such as pardon for past evasions, non-implementation of legislative powers to investigate and prosecute are promised to declarants. Although tax amnesties are said to induce future compliance, studies have proven otherwise. Thus leading to a loss-loss situation where neither back taxes due are collected nor future compliance have been achieved.

### C. Costs v Benefits

As reiterated throughout the paper, benefits are mostly theoretical. Short term revenue gains, hike in voluntary tax compliance have been highlighted throughout. Additionally, citizens who become tax delinquents by mistake who would like to make amends can also make use of amnesties. (Zeckhauser and Leonard, 1986)

Costs also include but not limited to: relatively small revenue collection even from the most successful amnesties. (Alm, 1998) Secondly, dissatisfaction amongst law abiding taxpayers, who feel that offenders are being forgiven whilst the honest pay their dues, will affect the tax morale of the country which will in turn adversely affect compliance. Again, previous tax evaders cannot be trusted that they will not fall back onto their old habits and continue evading tax payments. Repetitive offenders are a reason for decline in post-amnesty compliance.

If the prevailing problems of a tax system are not addressed by an amnesty, it is likely to do more harm than good. (Alm, 1998) As official data on the performance of an amnesty is rare, empirical evidence on effects of an amnesty is also rare. However, Alm and Beck who analysed the effects of the Colorado tax amnesty of 1985, found that long run revenue impact of an amnesty is likely to be negative. Furthermore, the average level of compliance fell after an amnesty. (Alm and Beck, 1993)

Das-Gupta and Mookherjee (1995) also supported the hypothesis of adverse compliance effects of amnesties or falling penalty collections overweighing direct gains of an amnesty. Only the 1975 amnesty amongst all amnesties introduced in India between 1965 and 1993 have had a positive impact on revenue. (Das-Gupta and Mookherjee, 1995)

According to Leonard and Zeckhauser, an amnesty is a political instrument and reduction of penalty must be coupled with a promise of more vigorous enforcement to win political approval of an amnesty program. A tax amnesty must not undermine the legitimacy of the tax system and the tax revenue that it collects. Public mistrust about the tax system and the government would lead to gradual decrease of compliance.

Some scholars have explored the relationship between tax amnesties and tax evasion. In theory, the cost of an amnesty must not exceed that of tax evasion. In other words, probability of detection should be high and tax amounts plus penalty payable if detected should exceed back taxes that have to be paid under (revenue collecting) amnesties. As a second factor, the costs side would be much heavier if psychic costs including stress over the probability of being caught and stigma are added. Thus amnesties seem to have lesser costs than evasion in any case concerning past fraudulent acts of non-compliers. In such circumstances, theoretically, tax evaders should be willing to come under amnesties. Based on this rationale, when back taxes are not collected under an amnesty programme, such amnesty should be excessively successful in bringing evaders into tax net as the overall benefit for evaders is the aggregate of whole back taxes with penalties in monetary terms and relief from psychic costs in non-monetary terms. (Hapuarachchi, 2005)

## IV. TAX AMNESTIES IN SRI LANKA

In the Sri Lankan context, tax amnesties have been a frequent occurrence during the last few decades with tax amnesties being declared in 1964, 1965, 1978, 1989, 1990, 1992, 1993, 1997, 1998 and the last one in 2003.

### A. The 2003 Amnesty

As the legislature governing the enactment of the 2003 amnesty (i.e. the Inland Revenue Special Provisions Act No.10 of 2003) states, the objective of the amnesty was to secure future compliance of taxes in force. Any person in Sri Lanka or abroad having undeclared income earned or assets acquired prior to April 1st, 2002 could make a declaration of such income and assets as at April 1st, 2002, to the CGIR on or before August 31st, 2003.

Declarants were exonerated from their past acts of non-compliance and evasion. Pardon was granted for omitted

payments that should have been made by those declarants under 26 enactments. Pardon for evasion of indirect taxes and wrongdoings against foreign exchange regulations and also import and export regulations were intrinsic to the 2003 amnesty. Levelled criticism prevailed over this aspect. The extraordinary coverage for unscrupulous acts and wrongdoings with regard to various types of taxes were argued to be to attract 'tax dodgers' who were unconvinced and not motivated to declare their acts of evasion under previous amnesties – which seems to have paid dividends when the number of declarations are taken into account. Queries, investigations and prosecution was not contemplated against the declarants and even actions already taken were waived off. The secrecy of the information received was strictly maintained.

Income tax liability for previously undisclosed income and assets up to the Year of Assessment (Y/A) 2001/2002 declared was pardoned. Where returns were filed by existing taxpayers, liabilities were finalised on the basis of such returns without any queries being raised. Appeals pending against any additional assessments, even before the judiciary, were settled amicably on the basis of income declared in returns. Existing taxpayers were able to declare previously undisclosed income and assets up to March 31st, 2002 without any burden whatsoever. From the Y/A 2002/2003, taxes must be paid under as one normally would.

For those without income tax files or with income tax files but no returns have been filed, all past undisclosed income and assets can be declared and taxes be paid from Y/A 2002/2003.

The 2003 amnesty persuaded 51,805 declarants with past evasions, to seek for forgiveness. This is a huge number compared to all previous amnesties under which the total declarants were less than 1000 as reported. Out of them, the most number of declarations (at 575) were under the 1965 amnesty. (Hapuarachchi, 2005)

## V. CONCLUSION

Tax compliance is a vital for a tax system as it simultaneously assists and determines the smooth functioning of other operations of tax administration, namely, assessment and collection. A variety of measures have been tried and tested by tax administrators worldwide in an attempt to facilitate and enforce compliance. One such measure is tax amnesties. The Sri Lankan government have often declared tax amnesties with the objective of persuading

non-complying citizens towards compliance leading to the observation that the state authorities seem to rate amnesties as better equipment. The rating is in comparison to the already existing enforcement and facilitating measures within the tax system. The higher ranking of tax amnesties is a result of other compliance enhancing measures failing to achieve the assigned objective. However, a criticism is that most tax amnesties employed in the Sri Lankan context enhanced compliance at the cost of tax revenue. The supporting argument for the same is that a tax amnesty should ideally function as a window of opportunity for citizens with a history of tax evasion to pay the due taxes on such evasion without being subjected to penalization or prosecution, which is sadly not the case in Sri Lanka.

Healthier options to counter the problem of non-compliance include prosecution and imposition of penalties on offenders, especially on those who do not submit annual declarations. At least, the time value of money can be recovered via penalties unlike in the case of tax amnesties where the whole of tax revenue is often lost when the evader is pardoned and freed from the liability of having to pay taxes evaded. Other measurements include auditing and investigations, collection of taxes due at source (i.e. Withholding taxes), use of information, field surveys and by maintenance of a taxpayer assistance centre.

In conclusion, it is evident tax revenue and expected number of files i.e. compliance is unlikely to increase meaning amnesties could work against the very objective of introducing them, where the administration is weak. Thus, an amnesty will do more than good if not executed perfectly. Sri Lankan tax system must rid itself of the vicious cycle of continuing to implement tax amnesties and focus on remedying the root cause than to apply a band aid on visible wounds.

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# CAUSATION AND THE LIABILITY FOR NON- DISCLOSURE OF RISK IN SRI LANKA; VINDICATING RIGHTS OF PATIENTS BY LIGHTENING PRINCIPLE OF CAUSATION

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**Abstract-** Informed consent is considered as one of the corner stones in medical practice and it is a socio legal obligation of medical professionals. Failure to disclose risk is considered as one aspect of medical negligence. Obligation to disclose risk was introduced by the Bolam principles in United Kingdom and has been subjected to later developments which has taken place in all over the world.

Doctrine of informed consent deals with the doctor's duty to inform the patient before proceeding with the treatment. Professional autonomy is now moving to the direction of patient's autonomy. Patients have a legal right to self-determination. Patients should allow to engage in critical decision making regarding their body and he can refuse the treatment, if he does not receive adequate information.

Accordingly, consent should be obtained by the doctor after providing all necessary information to the patient. However, in informed consent cases, it is a big barrier for the patient to prove that the failure to disclose information regarding the recommended treatment has led to cause the injury.

Following the qualitative research method this paper aims to discuss the evolution of the law of informed consent. Furthermore, this will examine the application of the test of causation in informed consent cases, while raising the necessity of lightening, moderating and sometimes even to depart from the requirement of causation cautiously by the judiciary, to vindicate patient's rights in informed consent cases in Sri Lanka.

**Keywords** - causation, consent, disclosure, patient, risk

## I. INTRODUCTION

Doctors are obliged to give information for patients regarding the treatment which they hope to undergo, and patients have the right to decide whether to undergo the treatment or not, considering the risks, benefits, and alternatives. Informed consent is a major area of medical malpractice and every medical practitioner should obtain consent of the patient to avoid liability before a treatment. According to the doctrine of informed consent, patients need information about the nature of medical treatment, its risks, and the feasible alternatives, to make an intelligent choice regarding whether or not to undergo the treatment (Sharma, N.D., 2015). According to law of negligence doctors owes a duty of care towards patients. This duty of care includes medical practitioners to take all reasonable steps and care regarding the treatment which is recommending and also regarding the provision of information to the patient.

Informed consent is a voluntary and explicit agreement made by an individual who is sufficiently competent or autonomous, on the basis of adequate information in a comprehensible form and with adequate deliberation to make an intelligent choice (Aveyard, H., 2002). Doctor owes a duty of care towards the patient not to cause any harm or damage to him/ herself and is liable for the occurrence of errors or errors of judgements. It is the duty of the doctor to obtain the voluntary consent of the patient before performing the procedure.



Every human being has a right to self-determination. According to Article 1 of the Universal Declaration of Human Rights, all human beings are born free and equal in dignity and in rights. Article 3 states that everyone has right to life, liberty, and security. Persons have a right to be free from torture (Article 5) and free from arbitrary interference with privacy, family, home, honour and reputation (Article 12). Further, Article 1 in International Covenant on Civil and Political Rights and International Covenant on Economic Social and Cultural Rights deals with person's right to self-determination.

Accordingly, if a doctor treats the patient without the patient's consent, it may amount to arbitrary and unlawful interference of the body and life of that person. Individuals have a right to take decisions regarding their life and body. To grant the voluntary consent, it is necessary for the patient to receive adequate information. Sufficiency of information may vary with the knowledge and the understanding of each patient. Further the information where the doctor feels as insignificant, may feel by the patient as significant and material to make an informed decision about the body.

There can be situations where the doctor was not negligent, and the doctor has treated the patient with due diligence. However, if the doctor has negligent in disclosing a small risk to the patient and unfortunately as a result, if the patient has been affected by that risk, a problem arises whether the patient could bring an action against the doctor, based on negligence of disclosing risk to the patient. In such a situation, according to the application of the traditional but for test in causation, patient must prove that the doctor's failure to disclose the small risk has an adequate causal link with the harm caused to the patient (Liyanage, U.S., 2008).

Even the doctor has negligently failed in providing sufficient information to the patient, if the patient is unable to prove that the failure to provide information has materially contributed to cause the final harm, patient's claim may fail in the court. It negatively affects patient's autonomy and right to self-determination and on the other hand it may be an arbitrary interference with the patient's body. So, there's a necessity of lightening and moderating the traditional requirement of causation to vindicate patient's rights in a negligent disclosure case, vigilantly and attentively by the judiciary in needy circumstances.

## II. OBJECTIVES

This paper aims to discuss the evolution of the law of informed consent. Following the above discussion, this paper will further examine the application of the test of causation in informed consent cases, while exploring the need of lightening and regulating the requirement of causation, cautiously by the judiciary, to vindicate patient's rights in informed consent cases in Sri Lanka.

## III. METHODOLOGY

Following the qualitative research approach, this paper reviews past literature and books, analyses case studies and statutes in the area of medical negligence particularly with reference to the informed choice of patients. This paper discusses the evolution of the law of informed consent in different selected jurisdictions highlighting the requirement of departing from the requirement of causation carefully by the judiciary, to vindicate patient's rights in informed consent cases in Sri Lanka. Reforms to the Sri Lankan law is proposed in the light of analyzed case studies, academic expressions and identified best practices around the world to make a balance between interest and rights of the medical professionals and the patients.

## IV. EVOLUTION OF THE DOCTRINE OF INFORMED CONSENT AND THE APPLICABILITY OF TEST OF CAUSATION

Informed consent is the process by which the treating health care provider discloses appropriate information to a competent patient, so that the patient may make a voluntary choice to accept or refuse treatment (Appelbaum, P.S., 2007). The consent should be given with full knowledge of the risks involved, probable consequences and the alternatives. The doctor or the healthcare provider must provide and disclose sufficient information to the patient or to the guardian to declare the consent. In modern medical practice, doctrine of informed consent is paramount important and the doctor must disclose the material risks inherent in the treatment and the patient should give the consent with full understanding (Mayberry, M.K., and Mayberry, J.F., 2002).

Doctrine of informed consent initially litigated under the principle of battery (Moore, G.P., et al, 2014). However, the concept of informed consent is now litigating under the field of negligence. If the doctor has acted in negligence in obtaining the consent of the plaintiff, it could be questioned under negligence malpractice. In such a situation, the patient must prove as similar to the elements of a negligence claim, that the doctor has failed to obtain the consent after informing necessary information, breach of duty as a prudent reasonable doctor, and the injury has caused as a result of the failure of disclosing the risk.

Recent trend in UK Law is that, if the doctor has failed to comply with this requirement it may give rise to a tortious liability. According to the Bolam principle introduced in *Bolam v Friern Hospital Management Committee* (1957) 2 All ER 118, a doctor is not liable if he has acted in accordance with practice accepted by responsible body of peer professionals. However, going beyond this, there are several recent UK and Australian cases which alarms to other countries regarding the necessity of recognizing the informed consent in a broader perspective.

In the case of *Bolam v Friern Hospital Management Committee*, McNair judge declared that “a doctor is not guilty of negligence if he has acted in accordance with a practice accepted as proper by a responsible body of medical men skilled in that particular art. Putting it the other way around, a doctor is not negligent, if he is acting in accordance with such a practice, merely because there is a body of opinion that takes a contrary view” ((1957) 2 All ER 118 at p. 121)

In accordance with the principles introduced in the Bolam case, duty of care must be judged according to the prevailing behaviour and the medical opinion at the time when the incident occurs. Accordingly, if the doctor has failed to disclose relevant necessary information to the patient or the guardian, peer professionals can decide whether it is below the expected level of standard or not. According to the dictum of McNair Judge in Bolam case, if a person wants to recover damages for the failure to provide relevant information and warning to him/herself, he should prove that the failure constitutes negligent. Further to prove the element of causation, he has to prove that if the doctor has provided required information and warnings for him, he would not have given the consent to undergo the treatment. This clearly demonstrates the burden which a patient has, in an informed consent case. In *Bolitho v. City and Hackney Health Authority* (1997) 4 All ER 771, a mother sued the hospital for the death

of her two-year-old son due to respiratory failure and cardiac arrest. Liability was denied by the doctor saying that, even if she has attended, she would not have done anything and it has been upheld by responsible body of peer professionals. When delivering the judgement, Lord Browne- Wilkinson declared that the court should analyze each situation by applying logical analysis test and the risk analysis test. Firstly, court must apply the logical analysis test to assess whether the opinion of peer professionals is structured, reasoned and defensible. Then the risk analysis test to assess the magnitude of the risk, comparative risks of alternative interventions treatments, seriousness of the consequences and the ease by which the risk might be avoided etc. Out of these two tests, the risk analysis test also relates to the option where a patient has to accept or reject the treatment of the doctor and it is closely related with the informed consent of the patient.

In *Maynard v. West Midlands Regional Health Authority* (1985) 1 All ER 635 as well as in another English case named *Sidaway v. Board of Governors of Bethlem Royal Hospital and the Mausley Hospital* (1985)1 All ER 643, Lord Scarman stated that, “a doctor is not negligent if he acts in accordance with a practice accepted at the time as proper by a responsible body of medical opinion...”

In this case, when considering the non-disclosure of risks to the patient, court stated that, doctors have no duty to elaborate remote risks to patients. In this case, the slight risk, which the doctor did not explained, materialized and the court by applying the Bolam principle dismissed the appeal. In this case Lord Bridge rejected the application of the principle of informed consent stating that, the principle of informed consent provides an insufficient weight to realities of doctor patient relationship and without judging the most suitable treatment to the patient, because of the application of the informed consent principle, the doctor has to think about the way of the best communication mode of the risks to the patient. Lord bridge pointed out the risk of the application of the principle of informed consent harshly, due to the knowledge and the communication gap between the doctor and the patient which can lead sometimes to feel that, even the information which is not significant to the doctor may be significant to the patient. Lord Scarman in this judgement stated that, the doctor has a duty to inform material risk to the patient and the materiality depends on facts of each case.

According to the evolution of case law jurisdiction it is important to exercise extreme care by doctors when dealing

with patients regarding the provision of information to the patient. Doctors must be very well cautious regarding the provision of comprehensive information with warnings to the patient, even about very small risks and possible outcomes may occur, and whether the patients have fully understood the information provided and, they should be given adequate time to take a decision based on the information provided.

Law should balance rights and competing interests of the parties in the society. Informed consent is a huge burden and a weightage for doctors, as it needs to spend more time on deciding which information may be significant to each patient rather spending time on deciding the most appropriate treatment. It may vary with the understanding and the knowledge of each patient. Moreover, if the judge is given the discretion finally to decide what a reasonable person would consider as significant information to avoid a significant risk, then the law may be unpredictable in such a situation. Further if the patient's condition has not occurred due to the negligence of the doctor as well as if it is a risk which may occur very rarely, it is hard to find a justification of deviating from established and existing principles of negligence to impose liability.

## V. CAUSATION AND INFORMED CONSENT

According to common law, there are two requirements in causation. First is the factual causation and the second relates to the appropriate scope of liability for the consequences of the negligent conduct (Carver, T., and Smith, M.K., 2014). Causation is one of a factor which needs to be proved in a medical negligence claim. It is a big obstacle when it comes to an informed consent case. After proving that the patient has not been provided adequate information by the doctor and he has not given the consent to run the risk of the treatment, the patient has to prove that, inadequate disclosure is the proximate cause of the injury where he/she is suffering. Further it must be followed by an objective criterion, which establishes that a reasonable prudent patient would not have undergone the treatment if he/she has been informed regarding the risk. Hence, establishing the requirement of causation is a huge obstacle for the patient in an informed consent case.

McNair judge in *Bolam v. Friern Hospital Management Committee* (1957) 1 WLR 582 stated that, a doctor is not negligent if he has acted in accordance with the practice accepted by peer professionals. However, in *Bolitho v.*

*City and Hackney Health Authority* (1998) AC 232, the court was given the power to reject the medical peer's opinion to do justice by applying logical and risk analysis tests. In *Sidaway case* (1984) QB 493, claimant's argument was that, if she has been warned, she would have refused the treatment that make her disable. Focusing to the 'reasonable doctor's opinion, court rejected the application of prudent patient test in this case.

In *Chappel v. Hart* (1993) MLR 223, the surgery carried by the doctor had an inherent risk and Dr. Chapperl failed to advice the said risk to the patient. As a result, Mrs. Hart consented to undergo the treatment and suffered a damage. Patient's argument was that, Dr. Chappel had been negligent in failing to warn the risk to her and if he has been warned she would not have undergone this damage and if she has been informed, she would have taken steps to perform it by an experienced surgeon or else may not undergo the surgery. In this case, the court upheld the fact that the injury has resulted but for the breach of duty of the doctor. Here the doctor has a duty to warn the risk and the doctor has negligently failed to inform the foreseeable risk to the patient and as a result the patient has not consented to run the risk. The court held that the requirement of causation has been proved.

In this case confusions arose with regard to causation. Here it was found that, if the patient had been informed the risk, she would not have refused the surgery, but would have postponed the procedure to be performed by an experienced doctor. The court upheld that the undisclosed risk is material and there's a probability of avoiding the risk by postponing the surgery.

Therefore, the court upheld that the test of causation was proved and the patient would not suffer the harm, if the surgery was done in a later date. By analyzing the requirement of causation in this case, High Court of Australia accepted the claimant's argument and stated that the court can override the principles of causation to vindicate the rights of plaintiffs, but with cautiously (Liyanage. U., 2008). Justice Gaudron, Justice Kirby and Justice Gummow was on the view that, even causation is an essential factor in an informed consent case, application of the but for test in its original form may create absurdities and irrationalities. The traditional but for test refers to whether the doctor's breach of duty is the cause for the claimant's damage. However, if it is clear that the claimant would not have undergone the injury, but for the defendant's breach of duty, the court has to consider it in detail, analytically by also considering policy reasons

(Chappel v. Hart (1993) MLR 223). Especially in a risk disclosure case, doctors have to be well aware of giving a risk disclosure and a warning to patients which is expected as a prudent patient in the society by also considering the policy reasons and other risks.

In *Chester v Afshar* case (2002)3 All ER 552, the patient claimed that the doctor has failed to warn her the small risk of cauda equana. The patient argued that she was not given substantial information about the risk to take a good decision. She further raised her arguments that the doctor's negligent failure to warn the risk has deprived her right to seek any other treatment to avoid from facing the treatment.

The court in this case considered the negligence of provision of information regarding the nerve damage to the patient. Further the court considered whether the doctor's omission has a causal link between the resultant harm. Under negligence, when proving the requirement of causation, patient has to prove that if sufficient and substantial information was received, he would have refused the treatment. In the aspect of causation, court applied the but for test to measure out whether the failure to inform the risk to the patient has directed to cause the harm. Here the claimant had to undergo a surgery which carries a 1-2% risk of worsening the patient's situation even it performed without negligence. The surgery was performed and it worsened her situation. The claimant's argument was that if she had been warned, she would not have taken the decision to undergo the surgery and will take time to consider the available options. The House of Lords decision in this case was not unanimous. Majority decision came in favour of the patient. Here in this case some judges tried to strictly apply strict legal principles while others re trying to deviate them to do the required justice and fairness considering policy matters (Heywood, R., 2005).

Lord Bingham in this case stated that, "... a claimant is also not entitled to be compensated, and a defendant is not bound to compensate the claimant for damage not caused by the negligence complained of". Lord Hope further stated that,

"... the function of the law is to enable rights to be vindicated and to provide remedies when duties have been breached. Unless this is done, the duty is a hollow one, stripped of all practical force and devoid of all content. It will have lost its ability to protect the patient and thus to fulfil the only purpose which brought it into

existence. On policy grounds, therefore I would hold that the test of causation is satisfied in this case. The injury was intimately involved with the duty to warn. The duty was owed by the doctor who performed the surgery that Miss Chester consented to. It was the product of the very risk that she should have been warned about when she gave her consent. So, I would hold that it can be regarded as having been caused, in the legal sense, by the breach of that duty". Accordingly, in this case majority of the judges accepted that the patient has established the causal link between the failure to warn the risk and the nerve damage where the patient has undergone and held that the doctor was liable.

However, in *Chester* case the court concentrated more on the necessity of respecting autonomy and dignity of a patient. The court is on the view that causation has been proved by policy grounds of assuring and respecting patient autonomy (Tay,C.S., 2007). In this case judges emphasized the necessity of departing traditional causation requirement, to vindicate rights of patients. According to Lord Hoffman in this case, Chester has to prove that if the surgeon adequately warned her, she would have avoided or reduce the risk by not undergoing the surgery. She failed in proving this thing and declared that she will undergo the same procedure in the future and the medical evidence suggested that the risk of cauda equina happens even it performed in a later date by another surgeon (Tay, C.S., 2007). Accordingly, she failed in proving that the doctor's breach of duty resulted her loss. And under traditional strict but for test under causation the doctor was not liable. However, she proved similarly in *Chappel* case that if she received substantial information, she would not have the operation at that time. Then the court has to decide the possibility of the occurrence of the small inherent risk, if the treatment has been delayed to another date.

Chance of a small risk eventuating is highly connected with the timing and circumstances of the surgery. Accordingly, delaying the treatment or changing the surgeon and the clinical settings may reduce the probability of materializing the small risk (Tay, C.S., 2007). According to Lord Steyn, "but for the surgeon's negligent failure to warn the claimant of the small risk of serious injury, the actual injury would not have occurred when it did and the chance of occurring on a subsequent occasion was very small".

Lord Hope in this case by taking a more broader approach stated that, medical negligence and informed consent cases needed to be considered in a wider perspective and causation is only one subsidiary and an additional matter which exists in that broad picture.

The majority decision of this case suggests that courts can depart from strict legal principles which governs causation since medical disclosure is not a static science (Tay, C.S., 2007). Consequently, the court, reflecting on the reasonable expectations of the public society accepted that the breach of doctor's duty to warn has resulted the injury. Therefore, it can be argued that if the injury is the result of the very risk that she should have been warned about and if the chance of occurrence of an injury on a subsequent occasion is very small, court can deviate from traditional causation requirements in information disclosure cases to vindicate patient's rights in a broader perspective by considering that the breach of duty caused the injury. The doctor has a duty to warn the risk. And on the other hand, it is essential for the patient to make an informed choice. In this case court emphasized and stressed the necessity of moving away from causation principles to some extent to protect patient's autonomy in informed consent cases.

In an Australian case, *F v. R* (1984) 33 SASR 189, court expressed an idea regarding the extent of information which needed to be disclosed to the patient in a normal and a complex situation. The Court stated that the amount of information which is necessary to be provided depends on the nature of the treatment, nature of the matter, patient's desire, and other surrounding factors. If the doctor has failed to disclose a material risk then it can be considered as breach of duty of care by the doctor. And if a reasonable person in the patient's position, if warned the risk will attach significance to it, then the risk must be considered as material.

In another Australian case, *Rogers v. Witaker* (1992) 67 ALR 47, High Court of Australia stated that, a doctor owes a duty of care to disclose information to the patient about the recommended treatment and the duty of care expected is similar to an ordinary skilled medical practitioner exercising that special skill. *Rogers* case imposed an obligation upon medical practitioners to disclose all inherent, material risks to patients and according to the majority decision of the case, risk is material if in the circumstances of the case, a reasonable person in the patient's position, would be likely to attach significance to it, if warned or if the medical practitioner should be reasonably aware that the patient, would be likely to attach significance to it if warned of the risk (Carver, T., and Smith, M.K., 2014).

UK judgement in *Montgomery v. Lanarkshire Health Board* 2015 UKSC 11, raised the standard of reasonable test from reasonable doctor to reasonable patient. *Bolam*

principle says that the doctor cannot be found negligent if he has acted and has declared information in accordance with a practice accepted by responsible body of medical men skilled in that art. This case changed this approach and came up with a new principle saying that, prudent patient standard in lieu of professional judgement is now the yardstick of duty of care.

With the change of this yard stick, a question arises whether it is reasonable to expect doctors to predict what patients want to know taking into consideration individualistic characteristics, needs, priorities and concerns of each patient. Nevertheless, Case law shows that the more patient centred approach has been taken by courts when it comes to negligent disclosure cases.

Negligence is the basic criteria which uses to measure inadequate disclosure cases. Adequacy of the doctor's disclosure and proving the causal link in such a case has become problematic. Disclosure cannot be solely determined on *Bolam* principle as well as on the prudent patient standard of disclosure introduced in *Montgomery* case. However, doctors have an obligation to adopt a patient centered approach in information disclosure cases and courts have to objectively assess whether the information which is significant to a reasonable patient have been disclosed, on logical and risk analysis basis. When determining adequacy of information provided and the causal link between the injury and the negligent disclosure, courts should follow an objective assessment criteria and has to deviate from traditional test of causation in needy circumstances.

## VI. APPLICATION OF INFORMED CONSENT AND CAUSATION IN SRI LANKA

Sri Lankan society considers that medical profession is a noble profession. Though number of accidents and injuries happens due to negligence of medical practitioners, reported cases are very rare in Sri Lanka due to attitudes and lack of knowledge of people. Though Sri Lanka has ratified several international conventions, right to life, patient's right to body and self-determination have not been given express recognition by the 1978 Constitution in Sri Lanka.

In the Supreme Court case of *Priyani Soyza v. Rienzi Arsekularathna* (2001) 2 Sri LR 293, law of medical

negligence was reviewed by Sri Lankan courts, even without directly referring to the principle of informed consent. However, the necessity of establishing the causal nexus between the negligence and the injury was highlighted in this Sri Lankan case. In this case, justice Dheeraratne stated that the expected duty of care from the medical practitioner is what is expected from a reasonable doctor in that art. This demonstrates that when determining whether the patient has given a chance to make an informed choice or not is determined by the Bolam principle in Sri Lanka (Liyanaage, U.S., 2008).

In Sri Lanka doctors can perform a surgery without patient's consent in an emergency. However, in normal situations doctors need to obtain the consent of the patient or the guardian prior to the treatment.

Duty to warn the material risk could be both proactive and reactive. Proactive duty requires disclosing information to the patient by the doctor where he/ she thinks as material to a reasonable patient and reactive duty requires the doctor to provide information in response to patient's questions (Carver, T., and Smith, M.K., 2014). In Sri Lanka, even though the doctors owe a duty under the law as well as under Code of ethics to obtain the consent of the patient prior to the treatment, a communication gap exists between the patient and the doctor, especially due to attitudes and several other reasons. There is no adequate discussion between the doctor and the patient or guardian before signing the written consent form (Liyanaage, US, 2008). Therefore, it is hard to identify whether the doctor has breached his duty of disclosure of all material risks prior to the treatment and whether the test of causation has been proved.

## VII. DISCUSSION AND ANALYSIS

Doctors are under a duty to inform their patients about the risks and benefits involved with the medical procedure. This is called the informed consent. If the doctor fails to get the consent from the patient, patient can sue the doctor for medical malpractice. Concepts of human right and patient autonomy has led physicians to the requirement of obtaining consent from the patient. Today patients have a right to be informed regarding the disease and the treatment and he has the right to self-determination. Informed consent has both an ethical value as well as a legal value. Ethically this can be justified from concepts of human rights and legally can be questioned under physical assault.

On the other hand, if the patients tend to bring more and more lawsuits against doctors, it will affect the doctor patient relationship adversely. In this case, doctors will tend to take decisions to avoid litigation rather than doing best for the patient. They will recommend more procedures to follow up, to show that they did everything that they could do to the patient. Also because of potential liability, there will be a shortage of doctors. The fear of malpractice liability has guided doctors to practice defensive mechanisms. Doctors will conduct tests and procedures not for furthering the diagnosis of the patient, but to avoid litigation. In this case doctors will provide care to their patients, which they think that will help to avoid law suits rather than paying more attention to patient's needs. Assurance behavior and Avoidance behavior are the two types of defensive medicine. As an assurance behavior doctors use to prescribe unnecessary drugs, additional tests, follow-ups, and referrals to show that the standard of care has been met and under avoidance behavior doctors avoid high risk, invasive procedures and treating high risk patients.

In today's world, great emphasis is placed on human rights. Universal Declaration of Human Rights (1948) recognized right to health as a human right (Article 25). According to Article 6 of International Covenant on Civil and political Rights (1966), every human being has the inherent right to life and this right shall be protected by law. These perspectives were supported by International Covenant on Economic Social and Cultural Rights (1966) by asserting the right of everyone to enjoy the highest attainable standard of physical and mental health (Article 12). South African supreme law, the Constitution says that everyone has right to life and right to freedom and security (South African Constitution (1996), Article 11 and 12) also everyone has right to access to health care services within available resources (Article 27(1)). As a common wealth country, Sri Lankan Constitution does not recognize right to life as a fundamental right. Right to health care services has not directly protected as a fundamental right by the Sri Lankan Constitution.

An American judge, in *Schloendorff v Society of New York Hospital* (1914) 105, NE 92 in his judgement states that "Every human being of adult years and sound mind has a right to determine what shall be done with his own body; and a surgeon who performs an operation without his patient's consent commits an assault". A question arises here regarding what factors have to be disclosed to the patient and how to decide whether there's a breach of duty of care by the doctor with regard to disclose or non-

disclosure of facts. Courts time to time gave restricted interpretations on this aspect and sometimes judges have given liberal and broad interpretations in sake of patient's rights. In modern world, patient has a right to be informed even a small injury. Significance of the risk and whether the risk is small or serious have to be decided by the courts, depending on facts of each case. Case law jurisdiction have moved away from professional standard to reasonable patient standard in negligent disclosure cases. Examples could be drawn from UK as well as Australian cases, in which the courts have deviated from traditional causation requirement to vindicate patient's rights.

This could be detrimental for medical professionals from their side. However rather relying on a leaflet or a small form, if there can be have an understandable dialogue between the patient and the doctor, for the patient to make an informed decision and if comprehensive and understandable information have been exchanged between the doctor and the patient, courts can decide whether to depart from causation requirement or not, to balance rights of each parties.

Standards of risk disclosure and the extent where the patient needs to prove the causation factor has not been dictated by a statute or by the judiciary in Sri Lanka. Adequacy of the information provided could be measured by courts using Bolam test as well as going beyond that using logical and risk analysis tests according to Priyanie Soyza case. Ideology of the principle of informed consent expects that the patient centered approach should be adopted, when measuring the standard of care as well as causation. It is the duty of the medical practitioner to empower and allow the patient to make the decision regarding their body. Deviating from the professional standard to prudent patient standard and departing from traditional but for test may create absurdities and it may lead to uncertainties in informed consent cases. However, court can justify it by highlighting the necessity of protecting patient's rights without exposing them to a preventable injury. If the disclosure of information to the patient is highly detrimental to the patient, doctor has a valid excuse to prevent from discussing information with the patient and even such a situation the court can depart from causation test when discussing the liability of the doctor.

Best interest and welfare of the patient should be the paramount factor in an informed consent case. In Montgomery, court declared that, the therapeutic exception cannot be used by doctors to prevent a patient from making an informed choice, even if the doctor

consider that it is against the best interest of the patient. The main objective of seeking the consent of patient is to uphold and respect the patient's autonomy. The philosophical concept behind this is the right based element. Law can't be remained in static. The law should change with the changes which take place in the society to provide the best answer for arising questions.

In Chappel and Chester cases, the court concluded that patient's rights and autonomy should be vindicated in informed consent cases, by taking a modest departure from traditional causation principles. Courts can cautiously override traditional causation principles and can base their decisions on policy considerations to provide justice and fairness to patients. On the other hand courts have to be aware not to allow the law to be an unsustainable vehicle for fraudulent claims Chester v Afshar case (2002)3 All ER 552 at 597 and also not to open floodgate of claims.

## VIII. CONCLUSION

Disclosing information is not a precise and a specific thing in all circumstances. To minimize the risks, it is necessary to alter and modify the principles associated with informed consent to some extent.

Therefore, it can be argued that if the injury is the result of the risk that a person should have been warned about and if the chance of occurrence of an injury on a subsequent occasion is very small, court can deviate from traditional causation requirements in information disclosure cases to vindicate patient's rights in a broader perspective also by taking into matter the policy considerations. The doctor has a duty to warn the risk. Correspondingly, it is essential for the patient to make an informed choice. Necessity of moving away from causation principles in needy circumstances to protect patient's autonomy in informed consent cases is essential by the Sri Lankan courts by using judicial activism is essential to vindicate patient's autonomy and their rights. The new judicial opinions will lay down guidelines for future conducts of doctors and may lead the doctors to take the consent from patients more seriously before treatments.

Therefore, court must concentrate more on the necessity of respecting autonomy and dignity of a patient. In addition to the formal requirements of a negligent action, policy grounds of assuring and respecting patient autonomy must be considered by the judges when there's a necessity to depart from traditional causation requirement, to

vindicate rights of patients by justifying the reasonable patient approach.

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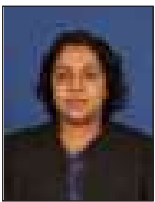
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# HEALTH INFORMATION PRIVACY AND RIGHT TO INFORMATION A CASE STUDY OF INDIA AND SRI LANKA

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**Abstract** - Privacy is a concept which is felt on a personal basis and accordingly it is difficult to define. Health information privacy is concerned with control, access and sharing of personal health information. Inherently personal health information possesses special degree of protection which originates through the traditional fiduciary relationship between the Doctor and patient. This paper is based on the findings of a research conducted on analysing the extent to which the right to privacy of personal health Information can be upheld while balancing it with the right to access for information.

The study is designed as a case study of India and Sri Lanka and data collection done through a survey of literature. After an analysis of the legal framework of the two jurisdictions it was found out that an individual cannot exercise complete control over all personal information they have to allow access to such information to certain parties depending on certain circumstances. Doctors, nurses and other health care service staff personnel need to access such information for treatment purposes. Further, such information needs to be accessed for public purposes such as health research, statistical purposes, prevention of contagious diseases and epidemics. Accordingly an absolute right to privacy of over such information cannot be entertained as it violates another person's right to access to such information especially in order to uphold the benefit of the public.

**Keywords** - privacy, health information, right to access information

## I. INTRODUCTION

Privacy is a concept which is felt on a personal basis and accordingly it is difficult to define (Gostin, 2002). Most

commonly cited definition for right to privacy is "right to be left alone" as it was expressed by Warren and Brandies (1890).

The Universal Declaration of Human Rights of 1948 also recognises right to privacy under Article 12 and it has been emphasized in International Covenant on Civil and Political Rights of 1966 under 17.

As Domingo (1999) expressed, the concept of privacy has different limbs including information privacy which involves control and access of personal information. Gostin (1993) defines health information to include all records that contain information that describes a person's prior, current or future health status, including aetiology, diagnosis, prognosis or treatment methods of reimbursement for health services. Accordingly Health information privacy is concerned with control, access and sharing of personal health information.

Ensuring protection for personal health information is important for number of reasons. Inherently personal health information possesses special degree of protection which originates through the traditional fiduciary relationship between the Doctor and patient. The historical Hippocratic oath says that,

"I will not divulge anything of a private nature regarding people's personal lives that I see or hear, whether in the course of my professional activities or not, because I recognize the shamefulfulness of revealing such information". (Gostin, 1993)

Personal health information may contain certain types of strictly confidential information about an individual such as sexually transmitted diseases such as HIV, mental disorders, genetic disorders and similar types of highly

sensitive information. If such information is revealed to the public, it can cause marginalisation in the society and can bring social stigma on such persons. Accordingly affording protection for privacy of personal health information within a legal system of a country is very important.

Two major approaches of protecting health information privacy can be identified around the world (Hiller, 2011) (Baumer et al 2004). One such approach is the introduction of specific laws in relation to privacy of health information. United States is the best example for such an approach where they have brought in Health Insurance Portability and Accountability Act of 1996 (HIPAA) and Health Information Technology for Economic and Clinical Health Act of 2009 (HITECH). Health Information Privacy Code of New Zealand 1994 and Personally Controlled Electronic Health Records Act 2012 are some other examples.

However, most of the countries have followed the second approach of providing protection for health information privacy through their general data protection legislation. Data protection Act of UK 1998, Privacy Act of Australia 1988, Personal Information Protection and Electronic Documents Act of Canada 2000 and Personal Data Protection Act No. 709 of 2010 of Malaysia are some of the examples

## II. HEALTH INFORMATION PRIVACY V RIGHT TO ACCESS INFORMATION

Scholars such as Fried (1968) and Rachel (1975) who believed in the control theory of privacy were of the view that privacy including health information privacy exists only when an individual possesses complete control over his personal information. However, scholars including Pelsak (2005), Culnan and Armstron (1999), Allen (1988) Gavison (1984) who followed the restricted access theory of privacy, reject the above approach where they argue that an individual cannot exercise complete control over all personal information they have to allow access to such information to certain parties depending on certain circumstances.

In the context of personal health information doctors, nurses and other health care service staff personnel need to access such information for treatment purposes.

Certain third parties such as employers and insurance companies may need to access such information for other purposes such as settlement of hospital bills. Additionally such information needs to be accessed for public purposes such as health research, statistical purposes, prevention of contagious diseases and epidemics. Accordingly an absolute right to health information privacy cannot be exercised and it has to be balanced with the right to information.

Accordingly the question arises as to the manner in which health information privacy and the right to information can be balanced. This paper is based on the findings of a research conducted on analysing the extent to which Right to privacy of personal health Information can be upheld while balancing it with the right to access for information. The study is designed as a case study of India and Sri Lanka and data collection done through a survey of literature.

## III. THE INDIAN APPROACH

The constitution of India 1950 does not contain an expressed right to privacy. However, the Indian Supreme Court has created and recognised a right to privacy utilising the right to life guaranteed under Article 21 of the Constitution. Accordingly in *Kharak Singh v. State of UP* (1963 AIR 1295) the Supreme Court held that

“It is true our Constitution does not expressly declare a right to privacy as a fundamental right, but the said right is an essential ingredient of personal liberty.”

The right so recognised has been upheld in the context of health information in a number of cases involving privacy of personal health information such as *Orchid Hospital vs Savita Gulyani* (Appeal No. A-2008/752) *Mr. 'X' vs Hospital 'Z'* (Appeal (civil) 4641 of 1998) and *Mrs. Neera Mathur vs Life Insurance Corporation* (1992 AIR 392).

Information Technology (Reasonable security practices and procedures and sensitive personal data or information) Rules, 2011 introduced under section 43A of the Information technology Act of 2000 recognises information relating to physical, physiological and mental health condition, sexual orientation and medical records and history as sensitive personal information. The rule provides for the manner in which such information can be collected, accessed and processed.

Accordingly it can be said that protection for right to health information privacy is well established in Indian legal framework. However, such right has been qualified in order to balance with right to information for public benefit.

This evident from the section 8 of the Right to Information Act of 2005 where it says that a request to disclose information provided in a fiduciary relationship or personal information that has no relationship to any public activity or interest not to be accommodated. This exception for right to information has been upheld in a number of Indian judgments involving application under the Right to information Act.

*Mr. Surupsingh Hrya Naik vs State Of Maharashtra IR (2007 Bom 121)*, the court reiterate that an disclosure of personal information which has no relationship to any public activity or interest, or which would cause unwarranted invasion of the privacy of the individual can be allowed under the Right to Information Act only if the Central Public Information Officer or the State Public Information Officer or the Appellate Authority under the Right to Information Act is satisfied, that the larger public interest warrants such disclosure.

In *Mrviqar Ahmad vs Gnctd (CIC/SA/A/2015/000289)* the applicant submitted an application under the Right to Information Act to gain access to a copy of the OPD slip and all the prescriptions of the applicants' ex-wife who was receiving treatment for a psychiatric disorder.

It was held that the request should be allowed even though the medical records are personal in nature as it can be justified for the public interest and for a purpose such as to justify the applicant's claim for the custody of three minor children which was the in issue in this case.

Also in the case of *Mrjyoti Jeena vs Government of Nct of Delhi (CIC/KY/A/2014/001348-SA)* which was a similar application for medical records of a psychiatric patient was allowed court to disclose such information about the medical records of her husband to the extent she needed to establish the disease her husband was suffering from in order to prevent cruelty against the applicant and the society due to his mental illness.

Accordingly it is obvious that health information privacy is not an absolute right in India and has been balanced with right to access for information for public benefit.

## IV. SRI LANKAN EXPERIANCE

Sri Lanka does not have an expressed right to privacy recognised under the Constitution of 1978. However, the common law of Sri Lanka provides some protection for privacy of personal information including personal health information under the common law action of *actio injuriarum* (Marsoof, 2008) (Amarasinghe, 1966). Protection for such information can be traced through the traditional fiduciary relationship between the Doctor and Patient. Further legal protection for personal health information can be secured through an expressed contract between the patient and the healthcare service provider under the contract law.

The Constitution of 1978 recognises the right of access to information under Article 14A and such right has been strengthened by the Right to Information Act of 2016. In order to balance the right to information with the right to privacy of personal information section 5 contains somewhat similar provisions to the Indian Act. It states that a request for access to information shall be refused, *inter alia* where-

- (i) the information relates to personal information the disclosure of which has no relationship to any public activity or interest, or which would cause unwarranted invasion of the privacy of the individual unless the larger public interest justifies
- (ii) the information could lead to the disclosure of any medical records relating to any person, unless such person has consented in writing to such disclosure;
- (iii) the information is required to be kept confidential by reason of the existence of a fiduciary relationship;

Accordingly it is obvious that while upholding privacy of personal information including medical records, exceptions have been provided for the public interest.

## V. CONCLUSION

In the aforesaid circumstances it is apparent that ensuring protections for Privacy of personal health information is very important. However an absolute right to privacy of over such information cannot be entertained as it violates another persona right to access such information. Accordingly balancing the two rights in order to provide for public benefit is very important. Accordingly as it was

held in the case of Md Majid Hussain S/O Hussain R/O vs Md Aqueel S/O Md. Abbas R/O H (Civil Revision Petition No.2129 Of 2014) ,

“No persons privacy can be invaded much against the consent and will of that person. However certain exceptions to this rigid principle are carved out to allow access to such information where larger public interest is involved.”

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Personal Information Protection and Electronic Documents Act of Canada 2000

Personally Controlled Electronic Health Records Act 2012    The Constitution of Sri Lanka 1978  
Privacy Act of Australia 1988    Universal Declaration of Human Rights of 1948  
Right to Information Act of India 2005  
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# SRI LANKAN LEGAL VERSION OF MIGRANT WORKERS' RIGHTS: HOW IT IS AND HOW IT SHALL BE

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**Abstract** - 'Migrant workers' are generally defined as people who leave their home country in search of employment. It is known that the largest source of income in Sri Lanka is foreign employment. Protection of the migrant becomes an integral need in this context. With the recent unpleasant tragedies occurred to migrants of Sri Lanka pose the question of actual protection of rights and its compatibility with the international standards. On the other hand protection of migrant worker is linked to the protection of families of the migrant worker. Thus the dependants, especially children of the migrants have the direct effect on deprivation of their rights and vice-versa. Therefore this social phenomenon enables the author to seek the legal protection of the migrant worker and its extent. Thereby this paper objects to compare the current domestic and international context on migrant workers' rights and to identify the key areas for improvement. The black letter and international and comparative legal research approaches were followed to analyze data. Related enactments and international standards as primary sources and journal articles, research publications and statistics published by authorities as secondary sources would be utilized in this research to recommend suitable legal reforms.

**Keywords** - Migrants, Protection of Rights, Foreign Employment

## I. INTRODUCTION

International Labour Organization (ILO) which is the international source of set-standards relating to employees defines "Migrant Workers" as people who migrate for employment (ILO, 1949). United Nations Convention on the Protection of the Rights of All Migrant Workers and Members of Their Families (UN, 1990) defines the

term as a person who is to be engaged, is engaged or has been engaged in a remunerated activity in a State of which he or she is not a national.

It is hard to control the scope of a person when he/she is not within the sovereign limits of a country. Yet the home country is responsible for departure, journey as well as safe return to the home country as per the international standards set out.

In this article it is focused on people who leave for employment and how their rights are protected through Sri Lankan legal framework.

## II. PROBLEM STATEMENT

Due to non compliance with the protection agenda in terms of migrant workers by Sri Lanka several tragedies stemmed out to people who left the country in search of employment. In a platform which requires solution and protection towards migrant employees, the need arrives to identify the gap between international standards and the legal framework relating to migrant workers. Therefore the problem which this article attempts to address is "What are the legal reformations Sri Lanka needs, to attain the best level of protection to migrant workers in par with international standards?"

## III. RESEARCH OBJECTIVES

**Objectives of the research are followings:**

- To identify international standards on migrant workers.
- To recognize the Sri Lankan legal framework on migrant workers' rights.
- To assess the gap between international standards and domestic legal framework.

To recommend suitable reforms to develop the Sri Lankan version on migrant workers' rights.

## IV. METHODOLOGY

This research is based on black letter approach and international comparative legal research methodology.

Black letter approach of research was used to gather existing knowledge on the protection of migrant workers and to have an in depth analysis on the Sri Lankan legal provisions applicable to the area of research.

International and comparative research methodology was utilized to analyse international standards on migrant workers to make recommendations on how Sri Lankan law can be developed/amended to accord a better protection to migrants as well as their families.

Two methodologies were carried out based on primary and secondary sources. Primary sources include the Constitution, related legislations, case laws and international standards and secondary sources include journal articles, conference proceedings, case commentaries, statistics and online articles.

## V. ANALYSIS

### A. Demographic overview

Foreign employment has become the largest source of foreign exchange in the Sri Lankan economy during the past few years. Since 1970's when formal employment migration commenced, foreign employment has generated substantial inflows of remittance while relieving pressure on unemployment of youth by providing employment abroad (Sri Lanka Bureau of Foreign Employment, 2015).

"Foreign employment opportunities have continuously helped to reduce the domestic unemployment pressure in Sri Lanka. Migrant workers originate not only from the unemployed and underemployed categories but also from the employed workforce. Outflow from the first two categories provide only a partial solution to the unemployment problem in the home country. It has helped to alleviate economic deprivation and frustration associated with unemployment to a significant level but does not offer a permanent solution to the unemployment issues of the country. (International Organization for Migration, 2009)"

It was revealed that over 48% of the Sri Lankan labour migrants are female housemaids with children (CWR, 2001) which turns migration into an issue on one hand. According to the United Nations Population Division, South Asians were the largest group of international migrants living outside of their home region in 2013. Out of the 36 million international migrants from South Asia, 13.5 million resided in the oil-producing countries in Western Asia (United Nations Population Division, 2013).

"...Migration policy in Sri Lanka is best understood within the wider policy framework of the economic policy initiated by the United National Party in 1977 which called for the introduction of private sector participation and market-based reforms. The oil boom in the Middle East spurred Sri Lanka's government to respond to the increased demand for labor which would provide a substantial windfall to Sri Lanka's economy through foreign workers' remittances... (Rosario, 2008)"

One of the main reasons for the high rate of labour importation by the Arab countries was the social conditions that emerged in the Middle East coupled with their economic development. The shortage of human resources in the Middle East was addressed by the Western countries by filling the gap for the skilled jobs and the shortages in unskilled jobs were filled by the Asians (International Organization for Migration, 2009).

### B. International Legal Framework

The international legal framework for the protection of human rights of migrants is very broad (Grange, 2006). It includes the Convention on the Elimination of All Forms of Racial Discrimination (ICERD, adopted in 1965), the International Covenant on Economic, Social and Cultural Rights (ICESCR, 1966), the International Covenant on Civil and Political Rights (ICCPR, 1966), the Convention on the Elimination of All Forms of Discrimination against Women (CEDAW, 1979), the Convention against Torture, and Other Cruel, Inhuman or Degrading Treatment or Punishment (CAT, 1984), the Convention on the Rights of the Child (CRC, 1989) and International Convention on the Protection of the Rights of All Migrant Workers and Members of Their Families (ICRMW) which are considered as 'seven core human rights documents'. Except the latter document other six international standards are applicable to all human beings, irrespective of their citizenship. Therefore in this article the discussion is limited to the rights protected by ICRMW.

ICRMW was adopted by General Assembly in 1990 and it is noteworthy that Sri Lanka is a party to the same. The Convention reiterates a number of rights applicable to migrant workers and members of their families that are included in the six international human rights instruments listed above, and highlights a few specific ones (Grange, 2006).

It is the first universal codification of the rights of migrant workers and members of their families in a single instrument (Lonnröth, 1991). It provides a synthesis of the human rights of migrants organized as a tool kit to better address the specific vulnerability in which they find themselves when they are outside their state of origin and at all stages of the migration process (Grange, 2006). Article 1 of the Convention states the application of the document and it mentions about application without any discrimination to all migrants and their families. Mainly three areas are covered from this UN document and they are (UN, 1990)

- Non-discrimination with Respect to Rights
- Human Rights of All Migrant Workers and Members of their Families
- Promotion of sound, equitable, humane and lawful conditions in connection with international migration of workers and members of their families

It is noted that provisions of the Convention corresponds with the rights recognized by existing human right documents and the only difference is the term “persons” or “individuals” have been replaced by the term “migrant workers and members of their families” (See Grange, 2006). Moreover the Convention specifically identifies rights of migrant workers in a regular situation as well as non-documented or irregular migrants.

Implementation of the rights recognized by the UN Convention is done by Committee on the Protection of the Rights of All Migrant Workers and Members of Their Families under article 72. (UN, 1990). Article 73 requires that;

States Parties undertake to submit to the Secretary-General of the United Nations for consideration by the Committee a report on the legislative, judicial, administrative and other measures they have taken to give effect to the provisions of the present Convention:

- (a) Within one year after the entry into force of the Convention for the State Party concerned;
- (b) Thereafter every five years and whenever the Committee so requests.

According to Grange,

“This Committee on Migrant Workers (CMW) will examine the initial and periodic reports submitted by each State Party. The Convention explicitly refers to the possibility for the Committee to “invite the specialized agencies and organs of the UN, as well as intergovernmental organisations and other concerned bodies to submit written information”. (Grange, 2006)

It was observed that Submission of reports as per the given guidelines under article 73 is very slow by Sri Lanka as a party to the Convention.

The Committee can also receive individual complaints. To activate this mechanism States Parties need to formally recognize the competence of the Committee to do so, by making a declaration under Article 77. However, none of the current 34 States Parties have made this declaration (Grange, 2006) and unfortunately it means none of the State parties to the Convention allow the remedy of ‘individual complaint mechanism’ to be utilized by its citizenry.

It is pertinent to discuss about how International Labour Organization (ILO) pursue migrant workers’ rights. Migration for Employment Convention (Revised), 1949 (No. 97) is the main set of standards prepared by ILO in this context. And Migrant Workers (Supplementary Provisions) Convention, 1975 (No. 143) provides supplementary to it. Article 1 of the Convention No 97 states that;

“...Each Member of the International Labour Organization for which this Convention is in force undertakes to make available on request to the International Labour Office and to other Members--

- (a) Information on national policies, laws and regulations relating to emigration and immigration;
- (b) Information on special provisions concerning migration for employment and the conditions of work and livelihood of migrants for employment;
- (c) Information concerning general agreements and special arrangements on these questions concluded by



the Member...” (International Labour Organization , 1949)

It enables a duty towards state parties to update the information often thereby make them they are easily available.

Article 2 entrust a basic duty to provide all services relating to migration for free. It is mentioned as “[e]ach Member for which this Convention is in force undertakes to maintain, or satisfy itself that there is maintained, an adequate and free service to assist migrants for employment, and in particular to provide them with accurate information. (International Labour Organization , 1949)

Other preceding articles (e.g. – Article 4, 5 and 6) in the ILO Convention establish the foundation towards protection of rights of the migrant workers.

It was observed to have relatively low rates of ratification for both abovementioned ILO Conventions. Convention No. 97 has 41 ratifications, and No. 143 only 18, making a total of 59 ratifications for both; 12 member States have ratified both instruments. The rate of ratifications has slowed in recent years. Since 1980, seven new ratifications were registered for Convention No. 97 and ten for Convention No. 143 (International Labour Organization, 1999).

As observed by ILO,

“... [o]n the whole the ILO instruments seem to have fulfilled their role in orienting national laws and regulations in certain areas, including the organization of migration flows.

Generally speaking, countries tend to follow the provisions made by the instruments in broad terms, but less so when it comes to provisions calling for more specific commitments, in particular with regard to the protection of migrant workers.

The international mobility of workers is today increasingly in the hands of private fee-charging recruitment agencies. Except where bilateral agreements on migration have been concluded between sending and receiving countries, the public services today have a minor and shrinking role in the recruitment and placement of migrant workers. This has negative aspects, however, since workers are vulnerable to malpractices...” (International Labour Organization, 1999)

Having an idea about the international legal framework it is worthy to evaluate the domestic version of migrant workers’ rights/ statutory protection.

### C. The Domestic Picture

Act No. 21 of 1985 established the Sri Lanka Bureau of Foreign Employment (SLBFE) which is responsible for governance and regulation of the foreign employment industry, protection and welfare of migrant workers and their family members, and promotion and development of employment opportunities for Sri Lankans outside Sri Lanka. Apart from SLBFE institution, private recruitment agencies represented by the Association of Licensed Foreign Employment Agencies (ALFEA) also play a major role in promotion of recruitment of labour (International Organization for Migration, 2009).

Moreover National Policy for Labour Migration adopted in 2010 needs to be noted in this context. It enables to promote opportunities for all men and women to engage in migration for decent and productive employment in conditions of freedom, equity, security and human dignity. Thus gender equality and decent work approach are the main objectives of the national policy. It also aims to articulate the state policy regarding Sri Lankan citizens engaged in employment in other countries and to recognize the significant contribution of all Sri Lankan migrant workers to the national economy through foreign exchange remittances and other mechanisms (NPLM, 2010).

Apart from above institutional and policy framework there are few Memorandums of Understanding between the Government of Sri Lanka and labour receiving countries like UAE, Jordan, Qatar and Bahrain. Main objective of these memorandums is to ensure the protection of and securing the rights of Sri Lankan workers, particularly women workers.

Moreover Sri Lankan trade unions had signed an agreement with their counterparts in Bahrain, Jordan and Kuwait to ensure the strict supervision and control of activities of recruitment and employment agencies as well as subcontractors and eliminate the abuse of sponsorship schemes (SEDEC, n.d.).

### D. The Evaluation

It is recognized that Sri Lanka has not ratified the ILO Conventions on labour migration which is a lacuna. Main reason behind this non-ratification is the requirement of free service. Article 2 of the

Convention No. 97 reveals that all the services relating to labour migrants shall be free according to the international benchmark. Yet Sri Lanka, through its SLBFE provides required services but not as a free service. Therefore Sri Lanka needs to amend its practices and legal provisions relating to SLBFE in order to ratify the aforementioned Convention.

It is noteworthy that UN Convention on the topic under consideration has been ratified by Sri Lanka and has failed to provide all the protection required by that instrument as well. On the other hand positive reactions of the government in terms of the UN Convention should be appreciated.

For example provision of assistance regarding contract making, free life insurance coverage to migrant workers, provision of Overseas Workers Welfare Fund (OWWF) provision of scholarships for children of migrant workers, provision of pre-migration loans and pre-departure training programmes need to be noted. This reaction by the government has commended by International Labour Organization in a published working paper as well. It states “As part of its regulatory function, the SLBFE has initiated and implemented a series of welfare measures to protect and promote migrants from abuse during the course of their overseas employment.” Following description as cited in Rosario (2008) would provide an idea about the aforementioned programmes by SLBFE.

- Pre-departure training is a mandatory requirement for all prospective migrants. A training certificate is awarded to migrants who have completed this process, and is submitted to the SLBFE along with their registration. Training covers a range of topics including language skills (primarily English and Arabic), home management, and cultural adjustment, Majority of migrants who receive training are female workers destined for the Middle East countries to work as housemaids. The SLBFE has 29 training centres all over the country. (Dias & Jayasundere, 2004)
- Skills Improvement is to be consistent with the mission of the Ministry of Foreign Employment Promotion and Welfare to upgrade the skills of Sri Lankan migrant workers, the SLBFE launched a joint program with the Tertiary Vocational Education Commission. This program is an outgrowth of Sri Lanka’s concern about the predominance of female migrants employed as housemaids abroad (Rosario, 2008).

- The issuance of model contracts by the SLBFE is used as a benchmark for employment agencies to ensure that conditions of work for Sri Lankan migrants are upheld (Rosario, 2008).
- Among the various objectives of the SBLFE is the establishment of the (OWWF). The Fund also possibly represents the most significant social protection measure for migrants, insofar as it attempts to provide a comprehensive system for migrants’ welfare (Rosario, 2008).
- Admittedly, the coverage of the insurance policy for migrants follows standard global practice (Rosario, 2008). However, there is little room within the policy to address various contingencies faced by migrants during the course of the employment overseas (Rosario, 2008). Based on complaints filed by migrants to the SLBFE, the most common are in the areas of non- payment of wages, breach of contract, and harassment (SLBFE, 2006). The insurance policy covers death, disability, and sickness only. Thereby the real issues faced by migrants such as breach of contract, non payment of wages are not covered by the insurance policy available to them. Statistics suggest that in the year 2006 reported number of deaths of migrant workers were 379 (SLBFE, 2006). In contrast reported complains regarding non-payment of wages were 6,638 and number of cases regarding breach of contract were 5,392 during the same period. Thus it is in dire need to reconsider the extension of insurance policy coverage to ensure a real protection towards migrant employees.

Apart from above, it is identified that legal framework of Sri Lanka lacks an enabling statute which recognizes rights of the migrant workers. Due to the dualist nature of the country, enabling statute is a prominent requirement to incorporate international standards into the legal system. Thereby ratification of UN Convention would not be completed without such enabling statute.

Moreover evidence of exploitation reveals that low skilled and unskilled categories of migrants are subject to high level of violation of human rights, including labour rights, harassment and abuse at the work place more than skilled professionals (NPLM, 2010).

Further In 2001, the Centre for Women’s Research estimated that around 10 per cent of the approximately 500,000 female migrant workers from Sri Lanka have been victims of some form of physical, psychological or sexual

abuse (CWR, 2001). Thereby it urges the need to enable legal protection to prevent and control such victimization.

## V. WAY OF BRIDGING THE GAP

Following recommendations can be made to bridge the gap between international standards and the domestic legal framework:

Sri Lanka requires an enabling statute to recognize UN Convention on the Protection of the Rights of All Migrant Workers and their Families, 1990 which can establish institutional and policy obligation.

Moreover it is required to ratify the ILO Convention No. 97 and the Convention No. 143 on migrant workers to incorporate best practices into the country by which Sri Lanka can follow ILO footsteps when developing domestic law.

It is required to improve Memorandums of Understanding between Sri Lanka and labour receiving countries to legally binding bilateral agreements to protect rights of migrant workers more specifically.

Sri Lanka Bureau of Foreign Employment should be empowered more to regulate employment agencies in terms of the obligation on their part. It is required to establish an obligation to facilitate the migrant worker from departure to return back to the home country. Governing body should be powerful enough to maintain discipline in every segment of migrant worker.

Moreover the social benefit schemes provided by SLBE currently need to be revisited corresponding actual need of the migrant worker as discussed above.

Not only the regulatory framework shall be created but also the implementation process requires thorough reference by the government in order to protect the rights of the migrant workers in the labour world.

Thus the migration policy should be strong enough to ensure migrant workers' rights while providing them a shading umbrella of protection.

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# THE IMPLEMENTATION OF CONSTITUTIONAL OUSTER CLAUSES IN SRI LANKA: A SISYPHEAN TASK?

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**Abstract** – The phrase ‘A Sisyphean task’ originates in Greek mythology, where Sisyphus, king of Ephyra, was condemned to an eternity of repeatedly rolling a large boulder up a hill, only to have it roll back down each time he reaches the top. This paper examines whether the implementation of ouster clauses has proven to be equally futile. Ouster Clauses (also known as privative, preclusive or exclusionary clauses) are legislative provisions which seek to exclude from the ambit of judicial review, certain acts or decisions of a statutory body.

Does the legislature repeatedly introduce such clauses, only to have the judiciary disregard them? The author views ouster clauses as pivots in the legal machinery, maintaining the delicate balance between the three organs of government. Therefore, it is critical to identify the role of the judiciary in maintaining that balance. The objective of this study is to identify a common thread in Sri Lankan judicial approach with regard to the specific category of Constitutional ouster clauses.

It is a discursive essay on how the courts have tackled the four main ouster clauses contained in the second Republican Constitution, focusing primarily on Article 61A, which is a comparatively recent addition; introduced by the 17th amendment and modified by the 19th. This shall be compared vis-à-vis the functionally similar Article 55(5) which existed prior to the 17th Amendment, in order to highlight any changes in judicial approach and the reasons underpinning such changes.

Through a qualitative analysis of Constitutional provisions and relevant judicial decisions, this paper addresses the key problem of whether the Sri Lankan courts have conformed to a general set of principles in interpreting Constitutional ouster clauses, or has implementation been solely dependent on how far an individual judge is willing

to go, disregarding the literal meaning, in the name of ‘judicial activism’?

**Keywords** - Ouster Clauses, Judicial Review, Constitutional Law, Administrative Law.

## I. INTRODUCTION.

Ouster Clauses (also known as privative, preclusive or exclusionary clauses) are legislative provisions which seek to exclude from the ambit of judicial review, certain acts or decisions of a statutory body. This concept is not a novel one, and such clauses have been a part of administrative law, especially within common law countries, for quite a long time. Since the seminal judgment in *Anisminic Ltd v. Foreign Compensation Commission* [1969] 2 AC 147, the courts have found ways to circumvent ouster clauses by refusing to adhere to the literal construction. They have justified the exercise of judicial review (to varying extents), notwithstanding the existence of an ouster clause, which ex facie seems to preclude such review. Thus, in many instances, the courts have exhibited a variety of judicial approaches in interpreting ouster clauses. This wide discrepancy in judicial approach with regard to how ouster clauses have been construed, consequently gave rise to heated academic debate as to how these clauses should be construed. The objective of this study is to identify a common thread in the judicial approach adopted by the Sri Lankan courts with regard to the specific category of Constitutional ouster clauses. It is a discursive essay focusing on how the Sri Lankan courts have tackled the four main ouster clauses contained in the second Republican Constitution, focusing primarily on Article 61A since it is a comparatively recent addition to the constitution, introduced by the 17th Amendment and modified by the 19th. Article 61A bears a close functional

resemblance to Article 55 (5) which existed prior to the 17th Amendment, as well as Article 106 (5) of the First Republican Constitution of 1972. This paper addresses the key problem of determining the extent to which the Sri Lankan courts have recognized the application of Constitutional ouster clauses and whether there is some consistency in judicial approach when construing such clauses.

Before carrying out an analysis on the interpretation of specific ouster clauses, it is important to understand the context within which such ouster clauses are born and the underlying principles which govern their application. Section A of this paper therefore observes the role of ouster clauses in the metaphorical tug-of-war between the three organs of government, by firstly examining the purpose of an ouster clause and secondly the reasons for circumventing such clauses.

Section B then delves into the Sri Lankan Context, where the classification of ouster clauses and the significance of such classification for the purpose of interpretation is explained, laying the foundation for an individual discussion on each of the 4 ouster clauses found within the Sri Lankan Constitution.

Following a cursory look at the first three ouster clauses, based primarily on Dr. Mario Gomez's observations, this paper then focuses its attention on Article 61A. Subsection 5 under Section B of this paper will compare the application of Article 61A with that of Article 55 (5), highlighting the differences in judicial approach, while the reasons for such deviation are discussed under subsection 6. Finally, Subsection 7 contains a brief explanation as to why Section 22 of the Interpretation Ordinance has no effect on ouster clauses found within the Constitution.

## II. METHODOLOGY

The study adopts the black letter approach, involving a qualitative analysis of both primary and secondary sources. The primary sources utilised for this research consist of the 1978 Constitution of Sri Lanka (along with relevant amendments) and relevant judicial decisions. Dr. Mario Gomez's textbook 'Emerging Trends in Public Law' with special reference to the chapter on ouster clauses was the secondary source which laid the groundwork for this research.

This study seeks to develop on Gomez's analysis by identifying recent developments and comparing the

changes in judicial approach since the advent of the 17th Amendment, with primary focus on Article 61A which was not a part of Gomez's analysis.

## III. RESULTS AND DISCUSSION

### A The Age Old Tussle

The introduction of ouster clauses by the parliament and their subsequent interpretation by the courts, is illustrative of the 'age old tussle' between the executive backed by the legislature on one side and the judiciary on the other.

#### 1) The Purpose of an Ouster Clause:

'Ouster clauses have been a parliamentary response to what the legislature considered was excessive judicial action in this area. Parliament has sought to eliminate litigation with its attendant developments and expense.' (Gomez 1998 at p.120)

Consequently, they would allow for quicker decision making and ultimately more efficient government, devoid of judicial encumbrances.

As Justice Wanasundara observes in his dissenting, yet widely quoted opinion in *Abeywickrema v Pathirana* [1986] 1 Sri LR 120;

"Every person acquainted with the post-independence period of our history, especially the constitutional and legal issues that cropped up during that period, would know how the actions of the Government and the Public Service Commission dealing with practically every aspect of their control over public officers were challenged and taken to the courts.

A stage came when the Government found itself practically hamstrung by injunctions and court orders and not given a free hand to run the public service and thereby the administration as efficiently as it would wish. The 1972 reforms came undoubtedly as a reaction to this. The thinking behind the framers of the Constitution was that the public service must be made the exclusive domain of the Executive without interference from the courts. Vide section 106." (at p.182)

The author argues that the ouster clauses contained in the present Constitution is a result of refining that same line of reasoning. This answers the apposite question of 'Why introduce ouster clauses at all?'

## 2) Justifications for Upholding or Circumventing an Ouster Clause:

The introduction of ouster clauses by the legislature is justified using the argument that these clauses protect both the legislature and the executive against judicial control and interference, thus upholding the well-established constitutional principle known as the Doctrine of Separation of Powers. This argument, supporting the need to uphold an ouster clause is further strengthened by the claim that; if the judiciary fails to give effect to ouster clauses, it would amount to a 'naked usurpation of parliamentary authority', thus resulting in 'judicial anarchy'.

The judiciary on the other hand, relies on another constitutional principle; The Rule of Law, to justify its position of circumventing or refusing to give effect to an ouster clause. The courts have argued that these clauses seek to undermine the peoples' right to be allowed access to judicial remedies, which is imperative to the operation of the Rule of Law.

They further contend that there is no point in having enabling statutes which specify (and thereby limit) an administrative authority's scope of power, if there is then a provision which prohibits the enforcement of such limitations.

Therefore, the courts have argued that they are not usurping parliamentary authority, but rather giving effect to 'parliamentary intent', since parliament could have never intended for administrative authorities to act with impunity.

### B. The Sri Lankan Context

#### 1) Classification of Ouster Clauses:

For an analysis within the Sri Lankan context, it is important to note the existence of two main categories of ouster clauses based on their source; those introduced by the Constitution (Constitutional ouster clauses) and those introduced by ordinary legislation (statutory ouster clauses).

The focus of this study is on the former. Constitutional ouster clauses can be further subdivided based on their subject; i.e. whether such clauses seek to protect decisions of the legislature or those of the executive branch.

Each of these categories warrant individual discussion, since the Sri Lankan judiciary has demonstrated certain distinct variations in their approach depending on the source and subject of a particular ouster clause. There are 4 main ouster clauses to be found within the provisions of the second republican Constitution of Sri Lanka; Article 80 (3), Article 81 (3), Article 61A and Article 154F (2). The first two provisions oust the courts' jurisdiction to review legislative acts, while the third and fourth seek to oust that with regard to executive and administrative action.

#### Mario Gomez observes the following with regard to Constitutional ouster clauses:

'The general principle the Sri Lankan courts have developed is this: a constitutional ouster clause will not protect administrative action which is ultra vires and without legal authority. However, the court will not question the validity of legislative action in the face of a constitutional ouster clause.' (Gomez 1998 at p.120)

While this paper does not refute the latter observation, the author contends that there has been subsequent case law which demonstrates a deviation in judicial approach with respect to the former, especially when it comes to questioning the validity of a decision itself and declaring it ultra vires. This study shows that in the recent past, along with the advent of the 17th and 19th amendments, the courts have in most cases, shown reluctance to review even executive or administrative action protected by a Constitutional ouster clause.

#### 2) Article 80 (3):

Judicial approach with regard to Article 80 (3), has been almost entirely uniform, in that the courts have accepted that; once a bill becomes law, its validity cannot be questioned on any ground. This was acknowledged by the Court of Appeal in *De Silva v. Kaleel* [1994] 3 Sri LR 138 at 149. The only deviation from this approach was seen in the Court of Appeal judgment in *Mendis and Fowzie v. Goonawardena and GPA de Silva* [1978] 2 Sri LR 322 (cited in Gomez 1998, p.120) where the court rejected the Respondents' argument that Article 80 (3) rendered the findings of the commission of inquiry, immune to writs. Gomez discusses this particular judgment at great length in his work (page 120-121). However, it is important to note that this exceptional ruling was overturned on appeal by the Supreme Court [1978] 1 Sri LR 166, thus maintaining the uniformity with which Sri Lankan courts have refused to circumvent the ouster clause under Article 80.

### 3) Article 81 (3):

A similar approach has been adopted with regard to the ouster in Article 81 (3), as was given judicial recognition by the Supreme Court in *Bandaranaike v. Weeraratne et al.* [1981] 1 Sri LR 10 (cited in Gomez 1998, p.118). This approach is indicative of the judiciary's reluctance to exercise its supervisory jurisdiction when the impugned act is by the legislature. Gomez also supports this as the reason for such a distinction (at page 107).

However, this paper wishes to highlight a fundamental difference between these two Articles, based on the nature of the parliamentary activity in each case. Article 80 deals with the ordinary legislative function of parliament; i.e. passing legislation. In contrast, Article 81 refers to the expulsion of members of parliament and the imposition of civic disabilities. Such an activity which involves imposition of penal sanctions is innately judicial in nature. Therefore, it is argued that in instances where the legislature performs a judicial function, a different approach should be adopted and that such actions should not be made immune to judicial review. It is the author's belief that intervention by the courts in such instances is completely justified.

### 4) Article 154F:

Moving on to the constitutional ousters guarding executive function, Article 154F (2) ousts the courts' jurisdiction to question decisions of the governor of a provincial council. As illustrated by the judgment in *Premachandra v. Major Montague Jayawickrema* [1994] 2 Sri LR 90 (cited in Gomez 1998, p.119), the Sri Lankan courts have adopted the view that; this particular ouster clause did not completely prevent the court from reviewing the governor's decisions. It is also worth noting that this ouster is comparatively weaker, in that it only prevents a decision made in the governor's discretion being called into question 'on the ground that he ought or ought not to have acted on his discretion'; i.e. the decision itself is not protected against review. Rather, it only precludes the courts from questioning whether such decision falls within the ambit of the governor's discretion.

### 5) Article 61A Compared with Article 55 (5):

As mentioned at the outset, the primary focus of this paper will be on Article 61A, being a recent addition which has not yet been the subject of much academic discourse. As NS Bindra points out in his treatise;

"the legislative language will be interpreted on the assumption that the Legislature was aware of existing statutes, the rules of statutory construction, and the judicial decisions and that if a change occurs in legislative language, a change was intended in the legislative result." (Bindra 1997).

Therefore, it is pertinent to examine the courts' approach with regard to its functionally similar predecessor-Article 55 (5), which existed prior to the 17th amendment before addressing Article 61A itself. Article 55 (5) reads as follows:

'Subject to the jurisdiction conferred on the Supreme Court under paragraph (1) of Article 126 no court or tribunal shall have power or jurisdiction to inquire into, pronounce upon or in any manner call in question, any order or decision of the Cabinet of Ministers, a Minister, the Public Service Commission, a Committee of the Public Service Commission or of a public officer, in regard to any matter concerning the 210 appointment, transfer, dismissal or disciplinary control of a public officer.'

The Sri Lankan judiciary has uniformly held that Article 55(5) would not oust the courts' jurisdiction if the impugned order is made by an officer who does not have the legal authority to issue it. In such cases our courts have held that the decision of the relevant authority is null and void and the preclusive clause in the Constitution does not bar review. This approach was recognized by the Sri Lankan courts, as demonstrated in cases such as *Abeywickrema v Pathirana* [1986] 1 Sri LR 120 and *Gunarathna v. Chandrananda de Silva* [1998] 3 Sri LR 265 (cited in Gomez 1998). However, it is important to note that the impugned decision cannot be declared a nullity if it has been adopted by a proper authority as required in the definition (per Sharvananda CJ at page 155 in *Abeywickrema*). This remains true with regard to Article 61A. Article 61A provides that;

'Subject to the provisions of paragraphs (1), (2), (3), (4) and (5) of Article 126, no court or tribunal shall have power or jurisdiction to inquire into, or pronounce upon or in any manner call in question any order or decision made by the Commission, a Committee, or any public officer, in pursuance of any power or duty conferred or imposed on such Commission, or delegated to a Committee or public officer, under this Chapter or under any other law.'

The judiciary has recognized that review is barred, unless the impugned act is not made by a Committee of the Public Service Commission or any public officer, "in pursuance



of any power or duty...delegated to a Committee or public officer, under this Chapter or under any other law.”; i.e. judicial review is precluded in cases where there is improper delegation. Moreover, operation of Article 61A being made subject to the provisions of Article 126, introduces the second exceptional circumstance where the supervisory jurisdiction of the Courts is not precluded; i.e. when there is an infringement or imminent infringement of Fundamental Rights.

Gomez cites the judgment in *Wijesiri v. Siriwardene* [1982] 1 Sri LR 171 to demonstrate judicial recognition of the view that an unlawful decision can be quashed (reviewed) notwithstanding the operation of Article 55 (5). ‘The modern trend after the decision in *Anisminic Ltd v Foreign Compensation Commission* (1969) 2 AC 147 is not to give effect to such preclusive clauses if the decisions sought to be quashed are proved to be unlawful; and that notwithstanding the fact that the preclusive clause is contained in a written constitution rather than in an ordinary statute would not afford an answer to unlawful acts of the executive.’ (cited in Gomez 1998, p.117)

This sets out illegality of a decision as grounds for review notwithstanding the operation of Article 55(5). In contrast, it has been established in *Ratnasiri and others v Ellawala and others* [2004] 2 Sri LR 180 that the validity of a decision cannot be called into question in the face of the Article 61A ouster. This view was reaffirmed in the subsequent judgment by the Court of Appeal in *Lokuge et al. v. Dayasiri Fernando et al.* (Unreported. C.A. (Writ) Application No.160/2013) Where Justice Nawaz declares that;

‘...the issue of mandamus would carry the implication from this court that the PSC has made an error in the first instance- a task which this court is constitutionally incompetent to engage in as a result of Article 61A of the Constitution.’ (At page 19)

This demonstrates that the Sri Lankan courts have been reluctant to question an error made by an officer with properly delegated authority. It is also worth noting that the justification given by the courts in *Siriwardene* can be interpreted as indicative of the judicial reasoning that Constitutional ouster clauses should not be treated any differently from an ordinary piece of legislation (At least to the extent of barring illegal acts from review). However, more recent cases indicate a greater degree of respect in the face of ouster clauses contained in the Constitution. The upshot of the comparison in judicial stance pertaining

to the two functionally similar ouster clauses; Article 61A and Article 55(5) can be summarised as follows: In both instances, the courts have uniformly accepted that review is not barred; firstly, when the impugned decision is ultra vires due to improper delegation and secondly when there is an infringement or imminent infringement of Fundamental Rights. Moreover, the judiciary has held that an act by an administrative authority can be reviewed on the grounds of illegality notwithstanding the operation of Article 55 (5), while in contrast, the courts have shown reluctance to question the legality of a decision in the face of Article 61A. This difference in the way Article 61A and Article 55 (5) has been interpreted is indicative of a deviation in judicial approach since the advent of the 17th Amendment.

#### **6) Reasons for Deviation:**

This study observes that the deviation in judicial reasoning was given impetus by other changes introduced in the 17th Amendment; primarily the abolishment of the pleasure principle and the availability of extra judicial remedies. An important feature of the Article 55 (5) ouster is that it gave effect to the ‘Pleasure Principle’ which is borrowed from English administrative law and recognizes that public authorities hold office at the pleasure of the crown. The existence of this principle was acknowledged by Justice Mark Fernando in *Bandara and Another v. Premachandra, Secretary of Ministry of Lands, Irrigation and Mahaweli Development and Others* [1994] 1 Sri. LR 301 at page 312. One of the major changes brought about by the 17th Amendment was the abolishment of the pleasure principle, spurned by the introduction of independent commissions. The introduction of the Public Service Commission brought along with it a series of extra judicial remedies. Article 58 (1) provides that any public officer aggrieved by a decision of a public officer or commission wielding authority delegated to it by the PSC, may appeal to the PSC against such decisions.

Moreover, a decision of the PSC itself may be challenged at the Administrative Appeals Tribunal appointed by the Judicial Service Commission pursuant to Article 59. Justice Saleem Marsoof observes that the changes imposed by the 17th Amendment are of relevance in interpreting Article 61A (*Ratnasiri and others v Ellawala and others* [2004] 2 Sri LR 180 at page 189-190). Commenting on the extensive list of provisions available to resolve matters relating to the public service, Justice Marsoof observes that this further strengthens the argument that the ouster in 61A should stand to preclude judicial review:

'In view of the elaborate scheme put in place by the Seventeenth Amendment to the Constitution to resolve all matters relating to the public service, this Court would be extremely reluctant to exercise any supervisory jurisdiction in the sphere of the public service. I have no difficulty in agreeing with the submission made by the learned State Counsel that this Court has to apply the preclusive clause contained in Article 61A of the Constitution in such a manner as to ensure that the elaborate scheme formulated by the Seventeenth Amendment is given effect to the fullest extent. (at page 190)'

In addition to these extra-judicial remedies, the author observes that by not barring review in instances where there is an infringement of Fundamental Rights, the option of seeking judicial redress is still left open to the people. Considering the significant pace at which the Sri Lankan Fundamental Rights jurisdiction has been expanding in recent years, it is even more understandable that the courts would not feel pressured to intervene, by attempting to disregard the express language of a Constitutional ouster clause.

#### 7) Effect of Section 22 of the Interpretation Ordinance:

The Interpretation Ordinance No. 21 of 1901 as amended by Act No. 18 of 1972 and Law No. 29 of 1974 sought to clarify the legal position with regard to ouster clauses after the seminal judgment in *Anisminic Ltd. v Foreign Compensation Commission and Another* [1969] 1 All ER 208. While Section 22 of the Ordinance supports the validity of ouster clauses in general, the proviso to the same section recognizes two exceptions where the Court of Appeal or the Supreme Court can exercise its supervisory jurisdiction; Firstly, if the impugned act is not within the power conferred upon the relevant authority (*ultra vires*) and secondly, where the relevant authority has not complied with the principles of Natural Justice or any other law which he is bound by. Thus, this provision gives the courts a wide berth in exercising its powers of review, notwithstanding the presence of an ouster clause.

However, this is not the case with regard to constitutional ouster clauses. Since the courts exercise its writ jurisdiction pursuant to Article 140 of the Constitution which requires such power to be exercised 'subject to the provisions of the Constitution', it has been accepted that an ouster clause contained in the Constitution itself would operate notwithstanding the exceptions set out in the Interpretation Ordinance.

In this regard, Justice Mark Fernando's application of the '*generalia specialibus non-derogant*' principle of interpretation in *Migultenne v The Attorney-General* [1996] 1 Sri LR 401 at 419 in interpreting sections 106 and 107 of the First Republican Constitution of 1972 would be of relevance. He argues that the specific provisions contained in the constitution itself would supersede the application of the general principle under the Interpretation Ordinance. This remains true with regard to the present Constitution. Thus, the provisions of the Interpretation Ordinance have in fact no effect on the operation of Constitutional ouster clauses in Sri Lanka.

## IV. CONCLUSION

The operation of ouster clauses is a prime example of the continuous tussle between the legislature and the judiciary. The legislature enacts ouster clauses with the aim of upholding the doctrine of Separation of Powers by protecting itself and the executive against control and interference by the judiciary, thus allowing for quicker decision making, devoid of judicial encumbrances. From the legislature's point of view, failure to give effect to an ouster clause is a usurpation of legislative authority. The judiciary on the other hand has expressed the belief that these clauses undermine the people's right to seek judicial redress and is therefore prejudicial to the operation of the Rule of Law. Thus, ouster clauses are pivots in the legal machinery which maintains the delicate balance between the three organs of government. The interpretation of such ouster clauses therefore plays a vital role in ensuring efficient government while safeguarding the rights of the people.

Four main Constitutional ouster clauses can be identified within the 2nd Republican Constitution; two which protect acts of the legislature against judicial review and two protecting the executive branch. The courts have quite uniformly expressed reluctance to intervene in the case of the former, whereas they have been more liberal in the exercise of their supervisory jurisdiction in the face of the latter category of ousters. However, the author wishes to highlight a fundamental difference between an ouster clause protecting the legislature exercising its legislative authority (Article 80 (3)) and one protecting the legislature in the exercise of an innately judicial function (Article 81 (3)). In the latter instance, the author advocates for a deviation in judicial approach so as to facilitate an effective system of checks and balances. It is argued that

an intervention by the judiciary in the face of this category of ouster clause would be completely justified due to the inherent judicial nature of the act which it seeks to protect. It is observed in relation to the two ouster clauses protecting executive action, that Article 154F (2) is comparatively weaker, due to the narrower scope of protection which it affords.

With regard to the ouster in Article 61A, the author observes that despite showing many functional similarities when compared with its predecessor-Article 55 (5), the newer provision has caused a distinctive deviation in judicial approach. While the courts have refused to give effect to the ouster in Article 55 (5) in cases where the impugned act was illegal, recent judicial decisions show that the courts when dealing with Article 61A, have uniformly shown reluctance to question the validity of a decision; i.e. the decision itself. The study shows that the courts have recognized only two instances where Article 61A does not preclude the courts from exercising its supervisory jurisdiction: Firstly, when there is an infringement or imminent infringement of Fundamental Rights and secondly, when the impugned decision is made by an authority whose power has not been properly delegated as specified in the Article; i.e. Instances of improper delegation. It is therefore the author's contention that the courts have been less inclined to exercise their supervisory jurisdiction in the face of the Article 61A ouster.

The study highlights several contributory factors underpinning this change in judicial approach, mainly focusing on the changes brought about by the advent of the 17th Amendment: Introduction of Independent Commissions, abolishment of the pleasure principle and the availability of an extensive extra-judicial appeal process as well as having recourse to the courts in the case of a Fundamental Rights violation. The author argues that the significant expansion of Sri Lanka's Fundamental Rights jurisdiction in the recent years would compensate for the courts' reluctance to intervene in other instances. Ultimately, this study observes that the Sri Lankan judiciary has for the most part adopted a uniform

approach with regard to constitutional ouster clauses, with the exception of Article 61A, where the courts have deviated from their approach to its functionally similar predecessor- Article 55 (5). Currently, the Sri Lankan judiciary exercises great caution and has often shown reluctance to disregard or circumvent Constitutional ouster clauses.

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# ILLEGAL FISHING BY INDIAN TRAWLERS VIOLATING THE MARITIME BOUNDARY OF SRI LANKA AND ITS IMPACT ON LIVELIHOOD AND THE INDO-SRI LANKA RELATIONS

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**Abstract** - Although, Indian and Sri Lankan fishing communities shared Palk Bay and Gulf of Mannar as their common fishing grounds for centuries, crossing of maritime boundaries for fishing purposes was prohibited after ratifying maritime boundary agreements in 1974 and 1976. However, Indian fishermen frequently enter into Sri Lankan waters and carry out illegal fishing creating numerous conflicts.

This study aims to identify the nature of illegal fishing practices carried out by Indian fishermen in the territorial waters of Sri Lanka and its impact on livelihood and the Indo-Sri Lanka relations. Primary data were collected from different stakeholders in Mannar and Jaffna areas through questionnaire and semi-structured interviews and secondary data were obtained from government institutions were used in this study. This study revealed that around 1000-1500 mechanized trawlers are coming to Palk Strait, Palk Bay and Gulf of Mannar regions three days per week to catch prawns and demersal fishes. Their average daily catch mainly consists of prawns (56 ± 11 kg; 31%), demersal fishes (116± 18 kg; 65%), sea cucumbers and squids (6±3 kg; 3%) and they have harvested approximately 1900 tons of shrimps and 4000 tons of demersal fish in 2016. Around 98% stake holders responded that Indian poaching is the biggest threat for their livelihood.

It was found that 22% of fishers permanently lost their livelihood and others are facing livelihood insecurities. Both countries have proposed some actions such set up Standard Operating Procedures (SOPs) to expedite

the release and handover of fishermen, intensify the cooperation on patrolling, and establish a hotline between coast guards of two countries to solve this problem, however, still could not find a long term solution. The northern Fishing community strongly suggests that the government of Sri Lanka must take strict security measures to protect its maritime border and actions to secure livelihood of fishers.

**Keywords** - Maritime boundary, Illegal fishing, Diplomatic missions

## I. INTRODUCTION

Sri Lanka is an island nation situated off the southeast coast of India. The maritime boundary of India and Sri Lanka is very close in the Palk Bay region where the minimum distance between the two countries is 16 km between Dhanushkodi on the Indian coast and Thalaimannar on the Sri Lankan coast (Vivekanandan, 2001). The fishing communities on either side of the Palk Bay, who are believed to have a common origin, have shared this area as a common fishing ground for centuries. However, crossing of maritime boundaries for fishing purposes was prohibited after ratifying maritime boundary agreements in 1974 and 1976 (Madanayaka, 2015). However, it is well evident that Indian fishermen routinely cross the International Maritime Boundary Line (IMBL) by violating the agreement between two countries and enter into Sri Lankan territorial waters to carry out fishing operations as most of the fishery resources in Indian side have been



**Figure 1: A snapshot of Indian Trawling in Sri Lankan waters (left side) and fishing vessel used by Indian poachers (Right side)**

already overexploited and depleted. According to recent statistics, there are around 5500 trawlers in Rameswaram and out of these around 2500 boats are directly depend on fishery resources in Sri Lankan waters (Adams, 2015; Vivekanandan, 2001)

The number of Indian fishermen enters into Sri Lankan territorial waters to carry out Illegal, unreported and unregulated (IUU) fishing by using illegal fishing method reported to be increased day by day creating numerous conflicts among fishermen of India and Sri Lanka, the governments of India and Sri Lanka and the Tamilnadu government. Several attempts, including diplomatic involvements have been carried out to solve this problem permanently, but still both countries fail to find a concrete solution to resolve this conflict.

This study was mainly focused to identify the nature of IUU fishing carried out by Indian trawlers in the territorial waters of Sri Lanka and its implication on livelihood and the Indo-Sri Lanka relations. An attempt was also made to identify the diplomatic mission carried out by the two countries to solve this problem to identify a long lasting solution.

## II. METHODOLOGY

Both Primary and secondary data were used in this analysis. Primary data were collected through questionnaires and semi-structured interviews targeting randomly selected fisherfolks, military personals,

professionals and academics in Mannar and Jaffna areas. Secondary data were obtained from the Sri Lanka NAVY, Ministry of Foreign affairs and Ministry of Fisheries. Data were analyzed qualitatively.

## RESULTS

### Nature of illegal Fishing

Around 1000 – 1500 mechanized boats of 32-42 feet, powered by 80, 100 and 120 HP are coming to Palk Strait, Palk Bay and Gulf of Mannar region (Figure 1) three days (Monday, Wednesday and Saturday) per week to carry out illegal fishing practices in the territorial waters of Sri Lanka. According to our observation Indian fishers are coming from Tamil Nadu, Andra and Rameswaram and all most all these fishers intentionally cross the maritime boundary of Sri Lanka for better fishing opportunities as Palk bay and Gulf of Mannar areas are very productive shallow fishing ground rich with natural seagrass beds and benthic communities.

Bottom trawling which is prohibited in Sri Lanka is the main fishing gear used by Indian fishers and their average daily catch mainly consists of prawns ( $56 \pm 11$  kg; 31%), demersal fishes ( $116 \pm 18$  kg; 65%), sea cucumbers and squids ( $6 \pm 3$  kg; 3%). Green tiger prawn (~90%) is the most dominant prawn in their catches and average price of 1 kg of green tiger prawn ranges from 650 – 750 LKR. Emperors, breams, snappers and groupers are the predominant demersal fish varieties and market price per 1 kg of demersal fishes ranges from 350 – 400 LKR. According to available statistics, in 2016, ~35,600 Indian

trawlers have engaged illegal fishing in Sri Lankan waters harvesting approximately 1900 tons of shrimps and 4000 tons of demersal fish. Normally they carry out 2-6 hauls per day making huge damage to the sea bed and associated seagrass beds, destroying feeding, nursery and breeding grounds of most of the fish and non-fin fish varieties as well as benthic communities.

### III. ILLEGAL FISHING AND LIVELIHOOD IMPACT

Fishermen of Northern Sri Lanka were extremely affected by the 30 years of war and now they consider the Indian poaching is the biggest threat to their livelihood. Around 98% of stakeholders responded that the livelihood of coastal fishers in the Mannar and Jaffna areas has been severely affected due to this Indian poaching and it was found that 22% of fishers permanently lost their livelihood due to the destruction of their fishing gear and vessels by Indian trawlers. The fishers who involve in their traditional fishing practices can now earn around 600 – 800 LKR per day, which is a three to 4 fold reduction of their usual income. More than 87% of fishers complained that they are not able to compete with Indian trawlers as they are using small mechanized boats (18 feet FRP boats powered by 9, 15 or 25 HP) or non-mechanized boats and their fishing gear are not very efficient as bottom trawlers used by Indians. Situation of Sri Lankan fishermen is grim as they cannot face the invasion by huge Indian fishing fleets therefore, fishermen avoid fishing on Monday, Wednesday and Saturday with fears of damaging their fishing gear by huge Indian fleet.

More than 92% of stakeholders concluded that bottom trawling has made adverse impact to the fish stocks as well as species diversity, especially in the Gulf of Mannar area by destroying sea bed and associated benthic communities and generating of the huge amount of by-catch and discards. The findings of this study indicate that fishers in this area fail to generate sufficient income to meet their basic needs through their traditional fishing practices which are their main income source for centuries. Fishermen in Jaffna and Mannar regions strongly highlighted that they are facing livelihood insecurities as a result of poaching their livelihood resources by Indians using illegal fishing practices and resulting permanent damages to highly productive and diverse fishing grounds in the Palk Bay and the Gulf of Mannar regions. Further, 73% of stakeholders pointed out that they are facing difficulties of getting fish for their daily consumption for a reasonable price as most

of the fish resources are taken by Indian fishers, limited access for local fishers to regular fishing and lack of proper security to carry out their traditional occupation.

### IV. INDO-SRI LANKA DIPLOMATIC INVOLVEMENTS

Sri Lanka and India have carried out several diplomatic missions to solve this conflict and several actions have been proposed and implemented from the recent past. Some of these recently proposed actions include setting up Standard Operating Procedures (SOPs) to expedite the release and handover of fishermen, ensure that there is no physical harm or loss of life while apprehending fishermen by both sides, intensify the cooperation on patrolling and periodic interaction between the coast guards of two countries, establish a hotline between the coast guards of two countries to ensure quick decision making, releasing vessels in each other's custody. It is claimed that one of the biggest threat for the Indo-Sri Lanka relations are the charges leveled by Tamilnadu fishermen and the government against Sri Lanka Navy of shooting and killing Indian fishermen who cross into Sri Lankan waters. According to Tamilnadu government, there were 167 incidents of shooting by the Lankan Navy during the last 10 years by killing 85 fishermen and injuring 180. Sri Lanka must address this issue promptly to avoid a serious crisis in the future

The Sri Lanka government strongly suggests that bottom trawling practices need to end at the earliest and Indian side assured that bottom trawling would be phased out in a graded time bound manner. Indian fishing fleets are rapidly growing and illegal fishing in the limited sea areas of the Palk Strait and Gulf of Mannar will not sustain for long time due to conflicts that have been arose fishermen in two countries as well as the rapid depletion of fishery resources due to overexploitation and destruction of highly productive marine ecosystem and benthic communities as a result of the use of harmful and illegal fishing practices like bottom trawling.

The Indian government is trying to take some actions such as directing of Indian fishing vessels to the international waters off the south of the Indian peninsula to reap good harvests and implementing buy back of existing trawlers to find a permanent solution for this problem. However, solving of this problem even through a diplomatic discussion seems to be not easy as Tamilnadu expects to reclaim the Kachchatheevu Island on "lease in perpetuity"

and permit license to Indian fishermen to fish within a designated area of Sri Lankan waters.

Northern fishing community of Sri Lanka raises a strong voice that the government of Sri Lanka must take strict security measures to protect its maritime border and the affected fishing community must be looked after by making an urgent action plan to ensure their livelihood with introducing additional income sources and alternative fishing activities. Further, they highlighted Indian government and the state government of Tamilnadu must take quick and prompt action to discourage Indian fishermen crossing into Sri Lankan waters.

## V. CONCLUSION

The livelihood of the northern fishing communities of Sri Lanka has been badly affected due to illegal fishing practices carried out by Indian trawlers violating the maritime boundary of Sri Lanka. Both India and Sri Lankan governments are trying to find a permanent solution to

this Indo-Sri Lanka fishing conflict in diplomatic level but yet to fail to find a creative solution.

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# THE OFFICE ON MISSING PERSONS (ESTABLISHMENT, ADMINISTRATION AND DISCHARGE OF FUNCTIONS) ACT, NO.14 OF 2016; A WAY FORWARD

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**Abstract** - Every human has the right to free from disappearances (enforce or involuntary) and the many states across the globe which were specially experienced the situations of conflict had took the initiation of protecting this right by introducing a specific legal framework for the same. The Office on Missing Persons (Establishment, Administration and Discharge of Functions) Act, No.14 of 2016 (herein after referred as OMPA) was one of the key statutes passed by the parliament of Sri Lanka during past year in order to establish the justice for the personals who had been subjected to the disappearances due to numerous conditions and situations occurred in the country during the stage of internal conflict and the post conflict era. The study is focused on assessing the level of accuracy and the effectiveness of the domestic legal framework introduced in order to protect the rights of personals subjected to disappearances with reference to the main international legal instrument, International Convention for the Protection of All Persons from Enforced Disappearance, 2006 (herein after referred as ICPAPEP) as appropriate. The study is based on legal research methodology which totally based on the assessment of the primary sources of domestic and international instruments. The study specifies few practical difficulties in implementing the introduced mechanism under the statute and appraises the level of protection available towards the rights of disappeared persons. The study concludes with recommending few amendments to the domestic statute, highlighting the necessity of guarantying effective intervention of the law and policy makers towards guarantying the right of free from enforce or involuntary disappearances in Sri Lanka.

**Keywords** - Missing persons, Enforce or Involuntary Disappearances, Rights, Sri Lanka.

## I. INTRODUCTION

The missing persons include those who are missing as victims of abduction, persons missing in action or otherwise missing in connection with armed conflicts, political unrest and civil disturbances. In the domestic context, this has been an outspoken issue with the unpleasant memories of disappearances of the people belonging to different social, cultural and ethnic backgrounds as a result of the numerous stages of the internal conflict situation which lasted for nearly three decades. Apparently, many claims were received by the relatives of missing personals against the state on non-guarantying the right to be free from disappearances. Recently, Sri Lankan government passed the statute of the Office on Missing Persons (Establishment, Administration and Discharge of Functions) Act, No. 14 of 2016, emphasising the necessity of guarantying the rights of the disappearances.

The preamble of the legislation recognised that the establishment of an Office on Missing Persons is necessary to take all necessary measures to search and trace missing persons; to protect the rights and interests of missing persons and their relatives (who are entitled to know the circumstances in which such persons went missing, and the fate and whereabouts of such missing persons) and towards ensuring non-recurrence.



The “relative of a missing person” shall in relation to such missing person include the spouse, children including adopted children, non-marital children, or step children, parents (including step-mother, stepfather, adopter), full or half-brother or sisters or adopted brothers or sisters, father / mother- in-law, brother/sister-in law, sons/daughters-in-law, grandchildren and grandparents (OMPA, 2016, s 27). The research question of the study is, does the mechanism established under the newly introduced statute of Office on Missing Persons (Establishment, Administration and Discharge of Functions) Act, No.14. of 2016 of Sri Lanka successfully guarantee the justice for the persons whose right to free from disappearances is violated in Sri Lanka?. The objective of the study is to assess the level of accuracy and the effectiveness of the newly introduced domestic legal framework, The Office on Missing Persons (Establishment, Administration and Discharge of Functions) Act, No. 14 of 2016, in order to protect the rights of persons who subjected to disappearances, either enforce or involuntary, with reference to the main international legal instrument, International Convention for the Protection of All Persons from Enforced Disappearance, 2006 as appropriate.

The study is based on legal methodology, which is mainly focused on black letter approach which critically analyses the provisions and approach of Office on Missing Persons (Establishment, Administration and Discharge of Functions) Act, No..14 of 2016 PDVA (2016) of Sri Lanka with the principles of Constitution of the Democratic Socialist Republic of Sri Lanka (1978). Further, the study reveals the standards and principles found in International Convention for the Protection of All Persons from Enforced Disappearance, 2006 in highlighting the global standards of guaranteeing the right of refraining from enforced disappearances. Moreover, the study emphasises the relevant and applicable standards/ principles in the other international instruments where appropriate.

## II. DEFINING “MISSING PERSONS”

According to the Section 27 of OMPA, Sri Lanka (2016), a “missing person” means a person whose fate or whereabouts are reasonably believed to be unknown and which person is reasonably believed to be unaccounted for and missing:-

(i) in the course of, consequent to, or in connection with the conflict which took place in the Northern and Eastern Provinces or its aftermath, or is a member of the armed forces or police who is identified as “missing in action”; or

(ii) in connection with political unrest or civil disturbances; or

(iii) as an enforced disappearance as defined in the “International Convention on Protection of All Persons from Enforced Disappearances”.

Sri Lanka is a signatory party to the ICPAPEP (2006) since 10/12/2015 and became a ratified state in 25/05/2016. Therefore, the statute is par with the definition of enforced disappearance mentioned in the ICPAPEP (2006).

The right of refraining from enforced disappearances has been recognized by Article 01 of the ICPAPEP (2006) and whenever situation of state of war or a threat of war, internal political instability or any other public emergency, may be invoked as a justification for enforced disappearance (ICPAPEP,2006,Art.01).

Further, the convention defines “enforced disappearance” as the arrest, detention, abduction or any other form of deprivation of liberty by agents of the State or by persons or groups of persons acting with the authorization, support or acquiescence of the State, followed by a refusal to acknowledge the deprivation of liberty or by concealment of the fate or whereabouts of the disappeared person, which place such a person outside the protection of the law (ICPAPEP, 2006, Art. 02).

## III. OBJECTIVES OF THE STATUTE

There are four objectives of enabling the OMPA, Sri Lanka (2016) as mentioned below in order to par with principles of the Article 10,12(1) and 12(4) of Constitution of the Democratic Socialist Republic of Sri Lanka (1978).

(a) to provide appropriate mechanisms for searching and tracing of missing persons, and to clarify the circumstances in which such persons went missing, and their fate;

(b) to make recommendations to the relevant authorities towards reducing the incidents of ‘missing persons’

(c) to protect the rights and interests of missing persons and their relatives

(d) to identify proper avenues of redress to which such missing persons or their relatives may have recourse (OMPA, 2016, s 02).

## IV. ESTABLISHMENT OF THE OFFENCE ON MISSING PERSONS (OMP)

The OMP shall be situated in Colombo and the regional branches will be established in order to achieve the mandate of the office (OMPA, 2016, s 03). The office shall consist of seven members and shall be appointed by the President with the recommendation of the Constitutional Council (OMPA, 2016, s 04). The term of the appointed member of the OMP is three years (OMPA, 2016, s 06) and they are qualified for the consideration of reappointment for one further term of three years only. (OMPA, 2016, s 07).

Part II of the statute specifies a comprehensive elaboration of the mandate, powers and duties of the OMP.

The OMP shall have the mandate to search for and trace missing persons and identify appropriate mechanisms for the same, and to clarify the circumstances in which such persons went missing, to make recommendations to the relevant authorities towards addressing the incidence of missing persons, to protect the rights and interests of missing persons and their relatives, to identify avenues of redress to which missing persons and relatives of missing persons are entitled and to inform the missing person

and their relatives, to collate data related to missing persons obtained by processes presently being carried out, or which were previously carried out and centralize all available data within the database established and finally, to do all such other necessary things that may become necessary to achieve the objectives under the Act (OMPA, 2016, s 10).

The powers vested with the OMP is of two types; general (OMPA, 2016, s 11) and investigative (OMPA, 2016, s 12), while the statute specifies a sound framework of functions of OMP (OMPA, 2016, s 13).

The OMP shall have a Secretariat which shall be charged with the responsibility for the administration of the affairs of the OMP (OMPA, 2016, s 16) including the OMP Teaching Unit (OMPA, 2016, s 17) and OMP Victim and Witness Protection Division (OMPA, 2016, s 18).

Every offence of contempt committed against the authority of the OMP shall be triable at the Court of Appeal as though it were an offence of contempt committed against the Court or Appeal (OMPA, 2016, s 25).

## V. CRITICAL ASSESSMENT OF THE OMPA

This section of the study is focused on assessing the framework established under the OMPA successfully guaranty the justice for the persons violated the right to free from disappearances in Sri Lanka.

The section elaborates few highlights of the statutes in the light of guarantying the rights of the missing personals.

### A. Lacun of public consultations process in drafting the OMPA

According to the official communication released by Dr. D. Udagama, the Chairperson of Human Rights Commission of Sri Lanka (2016), the statute might have obtained much legitimacy, if it had undergone a public consultations process in pre-grafting process of the law. The public consultations process must be an essential ground work in order to recognise the nature of the issues/expectations exits and identify the proper means of settling issues relating to missing persons in different capacities and/or conditions.

### B. The political authority and the discretion on the appointment of the membership of the OMP

The members of the OMP shall be appointed by the President on the recommendation of the Constitutional Council. The political ideology of the Constitutional Council definitely effects on the final selection of the seven members and similarly on the office of the Chairman even the statutes specifies that the composition of the OMP should reflect the pluralistic nature of the Sri Lankan society and previous experience in fact finding or investigation, human rights law, international humanitarian law, humanitarian response, or possess other qualifications relevant to the carrying out of the functions of OMP(OMPA, 2016, s 4).

Further, the statute provides a platform to the Constitutional Council itself to dominate and control the sole authority of the OMP since their recommendations shall be upheld anonymously as the members of the OMP where If the President is unable to appoint the Chairman on the recommendation of Constitutional Council within fourteen days (OMPA, 2016, s 5).

Similarly, the term of the members of the OMP is three years and subject to the consideration of the re-appointment (OMPA, 2016, s 6).

Therefore, it is controversial whether the composition of the OMP would successfully achieve the objectives of the establishment and the mechanism.

### C. Ensuring the effective functioning of the OMP

When establishing the office, particular attention has to be paid to the recruitment of staff to ensure that they are persons of unimpeachable integrity, have no prior allegations of human rights violations against them, and have the ability to be empathetic to the needs and concerns of victims and the families of the disappeared (Udagama,2016).

Further the objective of effective functioning of the OMP shall be strongly established if the staff had been recruited in consideration of too adequate gender, ethnic, and regional representation and language proficiency.

To ensure transparency the OMP has to formulate and widely publicise information on its methods of operations and procedures to which it adheres, including rules regarding confidentiality, guidance to families on how to approach the OMP and their rights in relation to obtaining information regarding progress of their complaint. Communication with victims should be in a language they understand (Udagama,2016).

The OMP should have personnel who are qualified to provide on-site psycho-social support to those who require it (Udagama,2016).

### D. The issues relating to issuance of the Certificate of Absence (COA)

Where the issuance of the Certificate of Absence (COA) is concerned, the families have to be made aware of their rights in this regard. Given previous reports of families of the disappeared being coerced to apply for death certificates, it is important to ensure they are in no way subject to any form of coercion to opt for a death certificate instead of a COA (Udagama,2016). The COA should be valid for a reasonable period of time to allow for the investigation of the disappearance and the person's fate. If investigations are on-going the COA should be valid until investigations conclude. Since both the OMP Act as well as the proposed Registration of Deaths (Temporary Provisions) Bill refer to the COA, it should be ensured the definitions and processes set out in both laws are consistent and provide maximum benefit to families of the disappeared (Udagama,2016).

## VI. THE WAY FORWARD

Finally, the study emphasises few key areas of the OMPA that need to be concerned and improved in order to guarantee the right to be free from disappearances and to ensure the rights of the missing personals.

- a. Need of continuous process of public consultations which may be an appropriate approach to recognize the issues in relation to missing personals.
- b. Assurance of establishment of rule of necessary discretion in appointing of the membership of the OMP.
- c. Establishment of an internal mechanism to address grievances of complainants regarding shortcomings in the functioning of the Office.
- d. Achievement and establishment of databases to document and preserve the work and records of previous commissions of inquiry as well as from diverse reliable sources after verification of facts to consolidate data on the disappeared and construct a single database.
- e. Guarantee the transparency of the OMP.
- f. The OMP should have personnel who are qualified to provide on-site psycho-social support to those who require it, for instance, during or after making statements to the OMP.
- g. The mechanism of OMP Act shall not envisage a victims of Crime and Witness Assistance and Protection Division. (Udagama,2016)

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# GREENING PATENT LAW: THE SRI LANKAN PERSPECTIVES

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**Abstract** - Environmental issues are one of the key areas addressed by technology. The patent system has the potential of enhancing technological development. However, despite the fact that promoting environmentally – valuable innovation has become a key area which requires national and international priority, the current patent law of Sri Lanka has failed to prioritize environmentally valuable patents. The recent Meetotamulla garbage dump disaster in Sri Lanka too reveals the non-availability of a potential tool to manage solid waste. Therefore this research aims to identify the existing patent legal framework of Sri Lanka with regard to green patents and its possibility to promote ‘green technology’. It is also aimed at scrutinizing how other jurisdictions have fast-tracked green patents and its relevance to Sri Lanka. Finally this research intends to propose a fast-tracked green system to Sri Lanka to promote environmentally valuable patents. In conducting the research, socio-legal approach was followed relying on both qualitative and quantitative data. Statutes and decided cases were used as primary sources and legal treatises, research journals and conference proceedings were used as secondary sources. Furthermore, information gathered through key informant interviews based on open ended questionnaires were utilized to glean empirical evidence. Moreover, comparative legal analysis concerning the legal framework in China and Sri Lanka was conducted in reaching the recommendations and conclusion. The findings reveal that the countries that have fast-tracked green patents, have achieved a significant development with regard to green technology. In achieving sustainable development, Sri Lanka too has a responsibility of addressing burning environmental issues such as energy efficiency, recycling and waste disposal. Therefore, an expedited system of green patents could be utilized as the initial effort in granting green patents in Sri Lanka.

**Keywords** - Green Patents, Green Technology, Environment

## I. INTRODUCTION

In a century where climate change has become the next great challenge for the humanities, innovation in green technologies (green tech) plays a crucial role in providing solutions to this problem. Intellectual Property law, more emphatically patent law is a great tool which promotes technological innovation. Green tech not only delivers environmental benefits, but also it is considered as ‘the biggest economic opportunity of the 21st century’ (McDermott, 2008). Being in the right track of achieving sustainable development, several national intellectual property offices in the world have taken steps to fast-track green patent applications. Australia, Brazil, Canada, China, Israel, Japan, Korea, the UK and the US (US had a pilot programme with regard to green patents which was initiated on 7th December 2009 and discontinued in 2012) have initiated such fast-tracking programmes. This mechanism prioritizes the green technologies in the examination and reduces the time taken to grant a patent from several years to a few months while incentivising the green techs (Dechezleprêtre, 2013).

As far as the innovation landscape of Sri Lanka is concerned, Sri Lanka has failed to make significant strides in the innovation and technological fields in the past six decades (Sampath, 2013). Even though Sri Lanka has been receiving a considerable number of environmentally friendly patent applications which involve green tech compared to the total number of domestic applications, it has not taken any step to expedite examination.

In this background, part 2 of this paper will explain the methodology followed in carrying out the research. The definition of green patents will be discussed in part 3. Part 4 will discuss how other jurisdictions have implemented

a fast-tracking programme for green patents and what lessons Sri Lanka can gain from such systems. Part 5 will discuss the Sri Lankan perspectives with regard to green patent applications. Part 6 will provide recommendations, followed by conclusion in part 7.

## II. RESEARCH METHODOLOGY

The research largely followed the black letter approach using both qualitative and quantitative data. In so doing, primary and secondary sources consisted of statutes, books, journal articles, blogs and web articles and Intellectual Property Office Databases. The research also followed the socio-legal approach and thus, key informant interviews were conducted based on open ended questionnaires in order to gather empirical data. Personal interviews with practising lawyers, academia, inventors and officers at National Intellectual Property Office of Sri Lanka (NIPO) were conducted. Thusly, socio-legal approach was followed, to include both theoretical and empirical aspects.

Furthermore, a comparative analysis was conducted to evaluate the fast-track programme introduced by other jurisdictions namely China and United Kingdom and to analyse what lessons Sri Lanka can gain from such systems.

## III. GREEN PATENTS DEFINED

Before shedding some light on green patents, it is essential to understand the meaning of 'green tech'. No specific definition could be found for 'green tech'. Agenda 21 adopted by the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992 used 'Environmentally Sound Technologies' to mean 'green tech' and defined it as technologies that 'protect the environment, are less polluting, use resources in a sustainable manner, recycle more of their wastes and products, and handle all residual wastes in a more environmentally acceptable way than the technologies for which they are substitutes' (Agenda 21, 1992). WIPO GREEN also corresponds to the same definition with regard to the scope of technologies ought to be traded under that (WIPO, 2012). Hence, 'virtually any technology can become 'environmental' when so applied' and the technology in the present context 'tends to be environmentally positive to the extent that it is less pollution- and resource-intensive' (Heaton Jr, 2015). On this basis, it is arguable 'green tech' is particularly concerned about protecting the environment.

Having identified the meaning of 'green tech' it is evident

that 'green patent' is granted for the environmentally friendly technologies. In terms of the definitions of many IP offices in the world, it is generally a patent which addresses the issues for instance, energy efficiency, alternate fuels, wind, solar, wave and nuclear energy, energy storage, waste disposal and recycling (Jinqian and Chong 2015).

## IV. GREEN PATENTS IN UK AND CHINA

Several National Intellectual Property Offices in the world have initiated fast-tracking programmes for green technologies. This section of the paper focuses on how two such programmes have helped to expedite green patent examination.

### A. The United Kingdom

The United Kingdom Intellectual Property Office (UKIPO) was the first country to introduce a fast-tracking programme for green technologies in 2009. This allows the applicant to request for expedited examination if the invention involves an environmental benefit. The applicant has to indicate in writing how his application becomes environmentally friendly and which action he wishes to expedite; that is whether search, examination, combined search and examination, and/or publication (Intellectual Property Office UK, 2014). In such a way the examination duration will be reduced from two to three years to nine months and it is free of charge. However, if it is directly related to environment such as solar panel, a brief statement would suffice. If not, a detailed explanation is required (Intellectual Property Office UK, 2014).

In UK, it is evident that all environmentally friendly inventions are eligible to participate in the fast-track program. 20.9% inventions out of the eligible inventions have requested for green patents as of 2012 since 2009 (WIPO, 2013). It was the highest percentage reported in a country that has the accelerated procedure. This is probably because, the accelerated examination in UK does not require any prior art search and charges no additional fee for accelerated examination (WIPO, 2013). Japan Patent Office requires a prior art search report creating an additional cost for inventors and only 1.4% of inventions out of the eligible patents have requested for green patents. This demonstrates that UK has not only fast-tracked green patent examination, but also encompasses the features that encourage the inventors to glean advantages

of accelerated examination. Moreover, 76% requests for green patents were UK based. During this period from 2009 to 2012 only 6 Chinese applications could be found in UK for accelerated examination (Dechezleprêtre, 2013). This reveals that the benefit of fast-track programme has actually gone to the domestic users rather than foreign applicants.

### B. China

China has been leading in the global energy race by attracting \$54.2 billion worth investments in 2013 in the clean energy market (The Pew Charitable Trusts, 2014). Being one of the fastest growing economies in the world China has a major concern over climate change. China became the second BRICS (Brazil, Russia, India, China and South Africa) country to introduce the green patent fast-track programme in August 2012.

In China, the applications that are eligible for prioritized examination include energy saving, environmental protection, new energy vehicles, low carbon technologies and resource-saving solutions that support environmentally-friendly development (SIPO Order No.

65 Article 4 (1) and (2)). The request for prioritized examination has to be submitted along with a search report (SIPO Order No, 65, 2012). Article 2 indicates that examination will be finished within one year.

The Chinese administrative measures on green patents reveal that the privilege of prioritized examination is granted not only to inventions with green tech, but also to applications that include new generation of information technology, biology, high-end equipment manufacturing, new material and also other patent applications that materially affect the national or public interest and require prioritized examination (SIPO Order No. 65 Article 4). However, if Chinese Patent Office has signed a bilateral or multilateral agreement with a patent office of another country which allows prioritized examination, priority is given to such agreements (SIPO Order No. 65 Article 3). Unlike the UK green channel, Chinese prioritized examination is not limited to green tech. Moreover, even though the Chinese system requires a substantive examination report when applying for accelerated examination, there is no such requirement in UK. Thus it is arguable that simplicity of the UK system is the reason to have a higher number of green patent applications. In this regard, UK fast-track programme is more encouraging than the Chinese programme. However, the Chinese patent acceleration examination system is still at its infancy to identify its pragmatic situation when compared to UK.

## V. THE SRI LANKAN PERSPECTIVES

### A. The Sri Lankan Patent Legal Framework

The advent of law of patents to Sri Lanka occurred in 1859 with the British Inventors' Ordinance (Hewage, 2015). It was followed by the Code of Intellectual Property Act No. 52 of 1979. The current governing law is the Intellectual Property Act No. 36 of 2003. This Act was enacted in compliance with the Agreement of Trade Related Aspects of Intellectual Property Rights of 1994 (TRIPS). With regard to patents, the Act provides provisions concerning definitions, right to a patent, requirements of application and procedure for grant of a patent, duration of a patent, rights of owner of a patent, assignment and transmission of patent applications and patents, license contracts and surrender and nullity of patents. Nevertheless none of the above chapters provide any provision to expedite the patent applications that carry environmentally friendly inventions. Draft Amendment Bills which came in 2012 and the Amendment Bill which was proposed in 2017 similarly do not contain any provision that deals with environmentally friendly patents.

### B. Why Sri Lanka Should Expedite Green Patent Examination

It was evident in the previous section that Sri Lanka does not possess any legal mechanism to expedite patent applications which carry environmentally friendly inventions. This does not mean that Sri Lanka is lacking inventions with green technology. The empirical evidence gathered from patent database suggests that domestic inventors have contributed to the fields of generating electricity from wave energy, solar energy, energy saving, environment pollution reduction and waste management (The categorization is based on a patent database search done by the author. National Intellectual Property Office of Sri Lanka (NIPO) does not have any mechanism to categorize such applications. Therefore a title search was done by the author using the data base of NIPO to find out in which green technological areas the applications have been received). In these areas of green tech, approximately 50% of the patent applications were local ones. Thus it could be argued that a fast-tracked green patent system has the potential of contributing a lot in the area of green tech.

Moreover, it was evident that in very rare cases based on the special requests made by the inventors, the

examination will be expedited by the NIPO. However this is not specifically for 'green tech' and even if the invention contributes to protect the environment, it may go with the time taking examination process. Generally the examination process takes from three months to five years. Thus, to incentivise the inventors in the field of 'green tech', a fast-tracked examination is of huge significance. A patent is a reward to the inventor or the creator (Cottier and Germann, 2008) in terms of the theory of 'reward by monopoly'. Environment being an imperative part of human life, it is logical to argue that there must be a mechanism to fast-track green patent applications since it would incentivize those who invent in the area of green tech.

Compared to the developed countries in the world Sri Lanka receives only a few patent applications per year. Hence one counter argument that may arise against the implementation of a fast-track programme is that, Sri Lanka does not need such a mechanism for green tech. But this stands contrary with the precautionary principle. Until the government gives priority to environmentally friendly inventions no one would specifically focus on such inventions. Hence, as a precautionary method when dealing with the environment, the country can allow 'green tech' to enter the market and the society at large and avoid the potential harms to the environment.

Meetotamulla garbage dump tragedy which took place recently, elucidates that Sri Lanka is lacking a suitable creative mechanism to manage solid waste. It does not mean that Sri Lankans have not invented inventions

concerning solid waste management. The data gathered from Patent Database suggests that many inventions that contain 'green tech' are still stuck in the patent examination process. Meetotamulla disaster opened the eyes of all Sri Lankans and made us think that it is now high time to give priority to inventions that carry 'green tech' so they can come into utilization soon.

According to the commercialization theory, a patent provides an incentive to invest. An invention with green tech has a friendly impact on the environment if invested as soon on them, because the impact of human activities on environment is irreparable. Thus fast-tracking would be an incentive to commercialize in future.

Even though some scholars comment that the inventors sometimes prefer to keep their patent application in the examination process so long, (Dechezleprêtre, 2013) the

UK scenario provides evidence that there is a demand for accelerated examination too. In UK the domestic applicants represented the majority in the total number of green patent applications from 2009 to 2012. Therefore, it is arguable that making aware about this type of programmes has the potential of increasing the participation which is in the same way can be applied in Sri Lanka.

The above discussion demonstrates that despite the fact that Sri Lanka is a developing country, viewed through the lens of environment, introducing a fast-tracked green patent system can be justified in Sri Lanka.

## VI. RECOMMENDATIONS

It was evident in the above discussion of this paper that Sri Lankan Intellectual Property Law regime does not address the issue of prioritization of green technology in patent examination. However, majority of the patent applications received by the NIPO include green tech. Therefore, being in the right direction of addressing the global issue of climate change, Sri Lanka too has a responsibility to fast track examination of the green patent applications. As in UK, the eligibility criteria has to be all 'environmentally friendly' inventions. That is because the Chinese categorization would create confusions among the inventors as to whether their invention is eligible or not. Furthermore, as far the Sri Lankan innovation field is concerned, an additional fee for accelerated examination would not create any demand for green patents. As discussed earlier in this paper, Sri Lankan inventors are much more enthusiastic in the areas such as wave energy, solar energy, energy saving, environment pollution reduction and waste management. Unlike UK and China Sri Lanka does not receive a large number of patent applications. Therefore it is adequate to mention that the invention is environmentally friendly or explain how it becomes environmentally friendly in the application. An additional step to submit a search report will not attract the Sri Lankan inventors in a context where only a few have been able to glean the advantages of the regular procedure even. In achieving this task in Sri Lanka specific regulations can be brought in prioritizing environmentally friendly patent applications. It must be further mentioned that, even though fast-tracking examination is appropriate as the first step, research funding, waiver of fees, disclosure of environmental impact in application process may also be taken into account in achieving sustainable economic growth.

## VII. CONCLUSION

Climate change is one of the major global issues that should be addressed before long. Intellectual Property Law could be identified as a tool which has the potential of contributing to the elimination of human activities on the environment by promoting green technological innovation. Thus whether it is developed or developing, each country has a responsibility to shape its law for the protection of environment. The need for more environmentally friendly inventions was evident by the recent Meetotammulla incident too. Australia, Brazil, Canada, China, Israel, Japan, Korea, the UK and the US have initiated fast-tracking programmes in patent examination.

Even though Sri Lanka is a developing country, it too has a considerable number of environmentally friendly inventions. Hence, Sri Lanka can introduce a fast-tracked green patent system as a significant step in working towards the right track of expediting green patent examination. Anything done for the protection of environment will ultimately be for the higher benefit of humans at large.

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# LEGITIMATE CAPABILITY OF EXECUTING THE DEATH PENALTY UNDER HUMAN RIGHTS LAW AND VALUES

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**Abstract** - The debate whether the death penalty should be carried out or not has been continuing from time to time in different parts of the world. Death penalty is creating an unnatural way of ending life and it is opposite to the recognized human norm of right to life. This right to life has been recognized in many international conventions and there are some international instruments which specifically focus on abolishing the death penalty. In this context the main research issue/problem for this research is to analyze whether a state is legitimately capable of carrying out the death penalty.

This legal research has used the doctrinal method which has utilized a critical, philosophical and comparative study method as the main means of coming to a conclusion. Under this method International conventions, declarations, Constitution of Sri Lanka, other legislations and regulations have used as primary sources and journal articles, text books and case laws have used as the secondary sources. Under the provisions put forward by the international instrument the state is positively obliged to protect the right to life and if a state allows carrying out the death penalty it amounts to the violation of state obligations. On the other hand, the state is bound to protect the life of individuals till people die of natural causes.

The death penalty is considered an unnatural mode of death and therefore, the state has no legal and moral obligation to do it. Furthermore, the beneficiaries of any human rights treaty are individuals and the state is responsible for granting these benefits to them. Similarly there are many other arguments that have arisen from human rights values which render a State legitimately incapable of executing the death penalty against wrong doers.

**Key words** - Death Penalty, Right to Life, State's Capability

## I. INTRODUCTION AND RESEARCH PROBLEM / ISSUE

The discussion whether the death penalty should be supported or not has endured from time to time in different parts of the world. Sri Lanka is not an exception to this discourse and it can be noted that, this debate re-erupts when a serious crime takes place. Particularly when sensitive murders take place this discourse erupts and in such situations most of the stake holders are of the opinion that the death penalty should be re-introduced in Sri Lanka.

It must be mentioned however that according to the human rights regime, many of international instruments, such as Right to Life, is considered the supreme right among all other human rights, since violation of the right to life can result in violation of many other rights and this right has been recognized in many of the international conventions. Further, giving the utmost protection to the right to life is considered as the main obligation the state party should perform towards its citizens. On the other hand, there are some international instruments which specifically focus on the abolishing of death penalty.

In this context the main research issue/problem for this research is to analyze the feasibility of carrying out the death penalty which is totally against human rights values. Therefore this research is mainly focused on the philosophical ideas forwarded by the human rights regime, in order to identify whether the states are legitimately capable of carrying out the death penalty for wrong doers

## II. RESEARCH METHODOLOGY

This law research used the doctrinal method which utilized the critical, philosophical and comparative study methods as the main means of coming to a conclusion. Doctrinal research Legal rules are normative in character as they dictate how individuals ought to behave (Kelsen, 1967). They make no attempt either to explain, predict, or even to understand human behaviour. Their sole function is to prescribe it. In short, doctrinal research is not therefore research about law at all. In asking 'what is the law?' it takes an internal, participant-orientated epistemological approach to its object of study (Hart, 1961) and, for this reason, is sometimes described as research in law (Arthurs, 1983).

Under this method International conventions, declarations, Constitution of Sri Lanka, other legislations and regulations have been used as primary sources and journal articles, text books and case laws have used as the secondary sources of this study.

## III. RESULTS AND FINDINGS

### A. How death penalty opponent to human rights Law

Right to life has been recognized and protected under many international instruments and state parties are under obligation to protect and ensure this right in their respective domestic arena. Article 03 of the Universal Declaration of Human Rights (UDHR) has mentioned that "Everyone has the right to life, liberty and security of person" (United Nations (UN) General Assembly, 1948). Further in the Article 6 of the International Covenant on Civil and Political Rights (ICCPR), this right is recognized and it is specifically mentioned that the execution of death penalty only for the most serious crimes in countries which have not abolished the death penalty (UN General Assembly, 1966).

Moving forward, Article 2 of the ICCPR mentioned that the state should take all appropriate means adequate to ensure the rights which are guaranteed under ICCPR (UN General Assembly, 1966). Therefore, if the right to life of any individual is arbitrarily taken by legislature, executive or judiciary, it amounts to the violation of Article 2 of the ICCPR. Additionally, the right to life has been recognized in the all major regional international human rights instruments including, African Charter on Human and Peoples' Rights, American Convention on Human Rights, American Declaration of the Rights and Duties of Man,

Arab Charter on Human Rights, European Convention for the Protection of Human Rights and Fundamental Freedoms and Inter-American Convention on the Forced Disappearance of Persons.

When discussing the international instruments which specifically focus on the abolishing of death penalty, the second Optional protocol to the ICCPR (1989) plays a vital role in this regard. Further, Protocol 6 to the European Convention on Human Rights focus about abolishing of death penalty in peace time and Protocol 13 to the same convention focus on abolishing of death penalty even in war time. Again, there is a protocol to the American convention on Human Rights to Abolish the Death Penalty. The United Nation Economic and Social Council (ECOSOC) adopted safeguards guaranteeing protection of the rights of those facing the death penalty in 1984. The General Assembly, as a main organ of the United Nations, also has passed resolution in this regard in years of 2007, 2008, 2012 and recently in 2014 Resolution 69/186 was passed under the theme of Moratorium on the use of death penalty.

All collection of instruments has paved the way to take a decision for state parties to take actions to abolish the death penalty in their respective countries. According to the current statistics more than 160 Members States of the United Nations with a variety of legal systems, traditions, cultures and religious backgrounds, have either abolished the death penalty or do not practice it. As pointed out by Richard C.D (n.d), the reasons why countries have abolished the death penalty in increasing numbers vary. For some nations, it was a broader understanding of human rights. Spain abandoned the last vestiges of its death penalty in 1995, stating that: 'the death penalty has no place in the general penal system of advanced, civilized societies....' (Hood, 2009) Similarly, Switzerland abolished the death penalty because it constituted "a flagrant violation of the right to life and dignity" (Hood, 2009).

In the famous case *Makwanyane & Mchunu v. The State* (16 HRLJ 154 (Const. Ct. of S. Africa 1995)) Justice Chaskalson of the South African Constitutional Court, stated in the historic opinion banning the death penalty under the new constitution that: "The rights to life and dignity are the most important of all human rights . . . . And this must be demonstrated by the State in everything that it does, including the way it punishes criminals. When discuss about the Sri Lankan situation it can be noted that, though Sri Lanka has not practice death penalty for more than 40 years as a sanction, it is still in the black

letter of the penal code (section 52) of Sri Lanka for many crimes. The last execution was in 1976. On the other hand, from the human rights aspect Sri Lankan Judiciary has recognized the right to life as a fundamental right in Sri Lanka although it is not explicitly mentioned in the 1978 Constitution of Sri Lanka in cases like Sriyani Silva Vs Iddamalgoda, Officer in Charge, Polica Station Payagala ((2003) 2 SLR 63). However, Sri Lanka has not ratified the second Optional Protocol to the ICCPR yet.

With the above description it is very clear that the execution of death penalty has been banded and limited by many of the international and domestic instruments.

### **B. How death penalty adverse to human rights value.**

The main value of human rights is the 'dignity' of an individual. The word dignity has undefined and it is considered as the basic understanding of human rights values, and furthermore, the state should take both positive and negative actions to protect the dignity of the individual. Without dignity none of the protections of the various legal human rights mechanisms can have real meaning. Right to Life is also in line with the right to live with dignity and until a person meets a natural death, the state should not take any action which would violate the dignity of individuals. The death penalty is considered as an unnatural form of death and therefore a state is incapable legitimately of causing an unnatural death.

In this context, some would argue the implementation of the death penalty only for serious crimes as a solution. Then the question arises, about the way of defining the seriousness of a crime. Some would decide according to the domestic law, while others will look for regional interpretations. Some will go further and will search for meaning given at the international level. Therefore it is obvious that, all the people would be unable to come to a consensus and most of the time it would be defined according to the context in which the crime took place. Then again, this would challenge the universalistic approach of human rights which means that all human rights should equally apply to all of countries and every human being. Human rights are set at universal level and it is obvious that all human rights cannot be given equal universalistic weight age in practical contexts. However, as mentioned earlier the right to life is a supreme right and it should not be given to the ruler's hand for bargaining.

Human rights treaties should always be identified by differentiating them from other treaties which require obligations from the country. This is because the main beneficiaries of any form of human rights treaty are the

individuals and government is made responsible for protecting and fulfilling these human rights obligations to its peoples. Human rights are safeguarded as fundamental rights by the Constitutions of countries and people should be capable of taking any action against a government if the government is failing in its obligations. According to the right to life also, the obligation by the state is to protect the right to life and not to deprive it by any means. Therefore it is again visible that the state does not have the power to cause an unnatural death even at a wrong doer.

The main purpose of building a state is to make sure that the people are safe within their jurisdictions. In very early stages of societies the survival of individuals is determined by the fact that who is having the power. It was the fitters of the survival situation.

However, all human beings had to live with fear and none of them felt the safety for their life. Therefore, with the emerge of the social contract concept the people handed over their power to the ruling party to obtain protection for life, liberty and property by allowing ruler to make rules and procedures on behalf of them. Consequently it is obvious the government is incapable of making a rule which helps to kill people. In this context someone would argue that the implementation of the death penalty would make the feeling of safety for others of the society according to the deterrent theory of punishment.

However, research findings on the relation between the death penalty and homicide rates, conducted for the United Nations (UN) in 1988 and updated in 1996 and 2002, concluded: "...research has failed to provide scientific proof that executions have a greater deterrent effect than life imprisonment. Such proof is unlikely to be forthcoming. The evidence as a whole gives no positive support to the deterrent hypothesis." For example in Sri Lanka we had the Penal Code from 1983 with all the prescribed punishments. We also had a time where death penalty was executed.

However, according to the prison statistics through past periods it is noted that prisons are overcrowded by large amount of number of prisoners who are imprisoned for different reasons and reconvictions and recidivism rate in Sri Lanka is high. In the year 2014, out of the total prisoners, 28.4 % were reconvicted and 17.1 % were recidivists. (Prison statistics 2015) Hence, what is expected from state party is the protection of right to life and not the destruction of human rights. If a country is executing the death penalty it can be considered a failure of the state positive obligations towards human rights obligations which they undertook to perform.

## IV. CONCLUSION

From all arguments forwarded in the section on results and findings, it can be noted that the state does not have legitimate power to execute the death penalty against wrong doers.

It is totally against the human rights obligations which were undertaken by a state party. Under human rights law and human rights, value this death penalty is not allowed. The state's duty is to ensure the safety and rights of human beings and not to violate their rights.

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# PROTECTION OF WOMEN IN NON INTERNATIONAL ARMED CONFLICT- A FEMINIST PERSPECTIVE

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**Abstract** – The legal regime of international humanitarian law is meant for protection for victims of armed conflict. It distinguishes two types of armed conflicts, namely: IAC, opposing two or more States, and NIAC, between governmental forces and nongovernmental armed groups, or between such groups only. This regime, however, has given an inadequate cover to non-international armed conflict and has been subject to severe criticism in this regard. The aim of this article is to critique the law for non international armed conflict in respect of women which is unknown, rarely discussed and addressed. During an armed conflict, women as civilians are generally forced into poor living conditions and are prone to accidents, injuries, and disease.

This paper is an attempt to reaffirm the inadequacy of the law on non international armed conflict and that has little to do with the protection of women. Thus, the methodology follows the normative research by analyzing the laws available for armed conflict, especially on non international armed conflict. Various treaties, customary international laws, and case decisions have been discussed in this regard. This paper will not offer a complete literature on international armed conflict.

However, it will discuss the provisions of international armed conflict containing protection of women to compare and contrast the protection for women under non international armed conflict. International law as a concept is gendered. Therefore it is not new to discover international humanitarian law is being gendered. The feminists on this area explain and question this. It is high time to go for an amendment or formation of new laws in International Humanitarian Law on women. Bringing a UN resolution on NIAC can work to fill the gaps of protection of women in this zone.

**Key words** - Women, Non international armed conflict, feminism

‘It is crucial that women’s voices are heard and their work on the ground is recognized, valued and supported. Decisions should be made with them, not for them’ – Elisabeth Rehn& Ellen JohnsonSirleaf

## I. INTRODUCTION

Violence against women is intertwined with traditions, practices and are entrenched in cultural values of societies there being no north- south difference in this regard. Infringement of human rights against women include sexual harassment, assault, domestic violence, incest and incidents of rape. Resort to obscenity against women, unwelcome advances, perverted acts, forced pornography and forceful prostitution are abhorrent expressions of relegating women to subjection. The concept of gender based violence necessarily includes both the aspects of violence, which arise out of asymmetrical power relations resulting in gender based discrimination inherent in the socialization process. When a state of affairs arising through an armed confrontation it is women who become most vulnerable . The bitter experiences of women and the traumas and trials which they have to undergo sometimes even leading to their deaths are not given commensurate adequate attention and commensurate heedfulness.

Out of the estimated more than one billion people that live in poverty today the majority are women. While there is a deplorable gender discrimination and undermining of women it is an unfortunate fact that it is left only to women writers to draw attention to the innumerable problems faced by women

It must be stated that the report written by .Radhika Coomaraswamy, UN rapporteur on violence against women, its causes, and consequences in the course of armed conflict is an outstanding document which has been used as a source document in my article .One hopes for more documents of this nature and not to confine them only to women writers

The legal regime of international humanitarian law is meant for protection for victims of armed conflict. It distinguishes two types of armed conflict, namely: International Armed Conflict (hereinafter IAC), conflict between two or more States, and Non International Armed Conflict (NIAC)ie between governmental forces and nongovernmental armed groups, or between such groups only. The international legal regime(IHL), , has given only an inadequate cover to NIAC and has been subject to severe criticism in this regard .This particularly applies to the failure in providing effective safeguards for the protection of women victims of armed conflict. Women not only experience conflict as civilians, but also often as female combatants because a large number are directly involved as combatants. The protection to women combatants through the provisions of separate dormitories and conveniences for women prisoners of war does not deal adequately with issues faced by women

Currently, the world is witnessing a number of armed conflicts such as in Syria , Iraq, Turkey, Yemen, Greater Sachel , Lake Chad Basin, Democratic Republic of Congo, South Sudan, Afghanistan, Myanmar, Ukraine, and Mexico. When one analyses the nature of these conflicts it has to be recognized that NIAC has now emerged as the most prevalent form of warfare. It has far outnumbered IAC.

The aim of this article is to critique the law for NIAC in respect of women a subject area which is , rarely discussed and addressed. During an armed conflict, women as civilians are generally forced into poor living conditions and are prone to accidents, injuries, and disease. Besides, they also suffer from risks of pregnancy and inadequate basic health services. One of the important concerns during armed conflict is the issue relating to the reproductive health of women. There are severe shortages of medicine, reliable birth control measures and medical treatment during NIAC. This issue was discussed extensively in the context of treatment of Muslim women in the former Yugoslavia.

The structure of this article is as follows; In the first place there is a need to understand the nature and magnitude of non international armed conflict; next as to protection

for women is available in IAC and NIAC and is to identify the gaps that exist in protection for women in international armed conflict(IAC) and non international armed conflict(NIAC) This examination would reveal and bring about a realization that the law for non international armed conflict is not developed and lacking in balanced gender perspectives. Whatever provisions that are available do not make much difference. Therefore there is a timely need to evolve protective measures for women in NIAC.

## OBJECTIVES OF THIS PAPER

Answering following questions

1. What are the laws on International Armed Conflict and Non International Armed Conflict?
2. How is the protection of women addressed in the law of armed conflict?
3. To what extent does the law of Non International Armed Conflict cover women?

## II. METHODOLOGY

This paper is an attempt to reaffirm the inadequacy of the law on NIAC with the protection of women. Thus, the methodology follows the normative research of analyzing the laws available for armed conflict, especially on NIAC. Various treaties, customary international laws, and case decisions have been discussed in this regard.

## LIMITATIONS

This paper does not cover a comprehensive literature survey on international armed conflict. However, it will discuss the provisions of IAC containing protection of women to make adequate comparison and contrast the protection for women under non international armed conflict.

## III . DISCUSSION AND FINDINGS

### A. INTERNATIONAL ARMED CONFLICT AND NON INTERNATIONAL ARMED CONFLICT.

Treaty and custom are the two important sources of International Humanitarian Law ( IHL) required to discuss the laws of IAC and NIAC and Treaties are often the codification of customs that are the reflection of state practices. Other than these two main sources, reports of

international law commission also play a significant role in identifying and interpreting the existing customary international humanitarian laws. Treaty law on IHL also establishes a distinction between IAC and NIAC in the meaning of common Article 3 of the Geneva Conventions of 1949 and NIAC falling within the definition provided in Article 1 of Additional Protocol II.

Geneva Conventions, customary international law and additional protocol I cover the IAC. Meanwhile, Common Article 3 and additional protocol II (Principle of such control over a part of its territory as to enable to carry out sustained and concerted military operations and to implement the present protocol) are dealing with NIAC. The law relating to NIAC is also a part of the public international law. Therefore the sources of international law will be applicable to the law of NIAC as well. So treaties, customs, general principles, judicial decisions and the writings of publicists are providing the sources of law in this regard.

Also, the study of sources of law regulating the NIAC will not be complete without attention to states and non state armed groups that include monitoring namely their ad hoc commitments. These ad hoc commitments of states and armed groups include agreements concluded between the parties, unilateral declarations and instructions or regulations that are internal to a party of the conflict. Determining whether an armed conflict is an International Armed Conflict or a Non International Armed Conflict is not easy as it seems to be. A proper definition was evolved in the Tadic decision is that, "an armed conflict exists whenever there is a resort to armed force between states or protracted armed violence between governmental authorities and organized armed groups or between such groups within a state". Most of the time applicability of international rules to NIAC is followed by the practice of states and non state armed groups which are actually included in NIAC. For example, following the end of the armed conflict in Sri Lanka in 2009, US made an assessment of the conduct of the parties to that conflict, to set out its own view of the customary international law status of certain rules relating to the conduct of hostilities.

At the treaty level, the International Humanitarian Law of NIAC includes Common Article 3, Additional Protocol II, Hague Convention on Cultural Property and its second protocol. It also includes various weapons treaties, such as the chemical weapons convention, the Biological Weapons Convention, The Convention on certain conventional weapons and Protocols like Ottawa Convention on Anti-

Personnel Mines, and the Cluster Munitions Convention. Further International legal instruments belonging to other areas of international law do play a role in NIAC, particularly, the Convention on the Rights of the Child and the Optional Protocol on Children and Armed Conflict, Guiding Principles on Internal Displacement, and the Rome Statute of the International Criminal Court. In addition to these, there are instruments at regional level to cover NIAC such as African Union Convention on Internal Displacement and The Cairo Declaration on Human Rights in Islam. In addition to this, the *lex generalis* International human rights law plays the role in filling gaps in law in the context of NIAC.

## **B. WOMEN UNDER NON INTERNATIONAL ARMED CONFLICT**

The purpose of this study is to focus on the humanitarian protection of women in NIAC. In order to differentiate the protection offered under IAC and NIAC, there will be a need to analyze humanitarian protection of women in IAC. Even though the status of women in IAC was recognized in order to provide protection, these provisions were limited to the physical integrity of women and the honor of their family. For example Treaty of Amity and Commerce mentions that "If war should arise between the two contracting parties ... all women and children... shall not be molested in their persons".

Application of rules relating to the protection of civilians and persons in non international armed conflict started with the instructions of General Dufour during Swiss Civil War in 1847 and Colombian War of independence in 1820. Following this Common Article 3 of the 1949 Geneva Conventions reflected those rules. As an aftermath of the developments of IHL, several provisions were introduced to cover the humanitarian protection for women in IAC. These are Article 2 of General Winfield Scott's General Orders, the Lieber Code, the Brussels Declaration and The Hague Regulations on Land Warfare of 1899 and 1907 and the Commission on the Responsibility of the authors of the War and on Enforcement of Penalties, 1919. All the above mentioned legal instruments ensure the equal protection of women in the context armed conflict. The loopholes of these laws will be discussed in comparison with those of NIAC.

Despite criticism of the Geneva Conventions and their 1977 Additional Protocols for taking an archaic view of the role and value of women as exclusively 'vulnerable', there are a number of provisions within these treaties

dealing with protections afforded to women as combatants. The provisions dealing with the protections afforded to women as combatants and prisoners of war are increasingly important. IHL is located within the concept of formal equality, and one sees reiterated throughout the Conventions and their 1977 Additional Protocols the requirement that protections should be provided 'without any adverse distinction founded on sex ...'. In relation to women who find themselves as prisoners of war, article 14 of Geneva Convention III reinforces this concept through the obligation that women should receive treatment 'as favorable as that granted to men'. Article 16 confirms this in the statement: 'Taking into account the provisions of the present Convention relating to rank and sex ... all prisoners of war shall be treated alike by the detaining Power'. Added to these claims of formal equality, IHL provides a range of specific protections to women, in particular for women detained as prisoners of war. For instance, women are required to be provided with separate dormitories and conveniences from men, even when undergoing disciplinary or penal punishment.

Furthermore, in the allocation of laboring tasks due consideration must be given to the sex of the prisoner. Disciplinary measures and punishments for women are not to be more severe than that accorded to males. It must be noted that unlike female civil internees, female prisoners of war have no specific rights to only be searched by a woman, which states that a woman internee shall not be searched except by a woman.

Today we can see rules such as the principle of humane treatment and rules relating to humanitarian assistance, and rules that relate to the protection of particular categories of persons like wounded and sick, the missing and the dead are all applicable in NIAC as well. In general the principle of humanitarianism is the basic principle that provides humanitarian protection to civilians and combatants in NIAC through Common Article 3 and Additional Protocol II.

Especially when it includes the humanitarian protection of women, such as principles relating to violation of personal dignity and sexual violence do play an immense role. Outrages upon personal dignity and sexual violence both fall under norms of customary international humanitarian law. According to ICTY, outrages upon personal dignity are essentially a subset of the broader prohibition on inhuman treatment. Similarly sexual violence like rape, enforced prostitution, indecent assault and threats thereof are all prohibited in Additional Protocol II. . Rome Statute

Article 8 (2) (e) (vi) also lists rape, sexual slavery, enforced prostitution forced pregnancy, enforced sterilization and other forms of sexual violence, as war crimes in their own right, rather than a subset of the prohibition on outrages upon personal dignity. Applying IHL laws to NIAC does not shield armed groups from the state. But they have no scope to prohibit the targeting of persons taking a direct part in hostilities, including non-state armed groups. Importantly, IHL has no provision dealing with detention, prosecution, the punishment of armed groups for criminal offences under domestic laws or prohibition of deliberate attacks against civilians. Apart from these, there are efforts by UN like the UN Security council resolutions to cover IAC and NIAC. Prof. Gregory Fox and Kristen Boon argue that the resolutions by Security Council have in fact imposed a set of obligations on NIAC parties and on third parties over the last few decades. Resolutions over Syria and Ukraine are examples. The Security Council shall determine threats to peace and breach of peace. . Accordingly under Article 25 of UN Charter, 'all members of the UN agree to accept the decisions of the Security Council in accordance with the present charter'. A number of Security Council resolutions have directly impacted on women in IAC and NIAC. Resolution 1325 on women, peace, and security (2000) deal with the impact of armed conflicts on women and girls. Also, resolution 1820 (2008) on sexual violence in conflict and post conflict situations have aimed at sexual violence against civilians in conflict zones. Under these, rapes and every other form of sexual violence can be treated as a war crime, a crime against humanity, or a constitutive act of genocide . Further , resolution 1888 and 1889 (2009) respectively deal with the protection of women and girls from sexual violence in armed conflicts and the protection of women and girls in post conflict situations. But there is not a single standalone Security Council resolution to exclusively focus on NIAC.

### C. FEMINIST PERSPECTIVE

It is not new to discover that international humanitarian law is being gendered. Most of the scholarship in this area explains and questions this aspect. Writings of Judith Gardam, Christine Chinkin, Amy Barrow and Helen Durham are such examples. There are enough writings highlighting the need for a law on NIAC since the IAC is having barriers such as state sovereignty to intervene in internal conflicts.

This article attempts to discuss the issue from a gender perspective. Women being the most affected party in NIAC do not meet with necessary justice in domestic



courts. Therefore feminist perspective voices are raised to bring common standard laws. Feminists have two criticisms on the International law in general which is applicable to IHL as well. They are the absence and exclusion of women in the international law making and role of gender in the formulation of international law. Systematic inequalities in international humanitarian law have always been a concern of feminists. For example, even though the UN Security Council 1325 recognizes women in armed conflict, it is still a question as to how much is it in practice.

The take of feminism on this topic points out that the laws on women in NIAC give more concern on dignity but not the offense by itself. Also the other problem with legal documents in NIAC is that they only focus on sexual violence on women ignoring other socio-economic effects on women during the internal conflict. It is true the decisions of Akayesu and Delalic have been progressed by identifying rape and forced pregnancy as crimes against humanity. But the further recognition in International Criminal Court is unanswered in Lubango by not answering the gender based crimes.

#### IV. CONCLUSION

The Law of NIAC has been developed since mid of 1990's and is being further developed. Even though there are provisions relating to this area under Article 3 of Geneva Convention and Additional Protocol II through the

reflection of customary international law, yet, there are gaps to be filled specially in the context of protection to women. There is not even influence of customary international law in this regard. Only domestic courts exercise their discretion in this matter. Under substantive law notions of combatant immunity and prisoners of war which are relating to women need to be considered. There is no guarantee for the status of prisoners of war also in the law of NIAC. Members of the military wing of the non state armed group who are captured do not benefit from provisions on prisoners of war. An important aspect of non international armed conflict is that it suffers from a particular matter of the relationship between the non-state armed group and the persons and objects in territory under its control. But as states see non-state armed groups as criminals or traitors, terrorists, there is no place for immunity. No rule of IHL or customary International Law related to the relationship of non state armed group and persons and objects in territory under its control is in place. The protection of women under IAC is without answers and protection of women under NIAC is without questions. It is high time to go for an amendment or formation of new laws in International Humanitarian Law on women. Bringing a UN resolution on NIAC can work to fill the gaps of protection of women in this zone.

<sup>i</sup> Beijing declaration and platform for action, UN.GAOR.UN DOC.A/Conf.177/20 (1995)

<sup>ii</sup> Geneva III, Art 14, 25, 29

<sup>iii</sup> Amnesty International Report of 1995

<sup>iv</sup> Report on European Community investigative mission into treatment of Muslim women in the former Yugoslavia 1993

<sup>v</sup> ICJ Statute, Article 38

<sup>vi</sup> Prosecutor V Tadic, IT-94-1-AR72, Decision on the Defense motion for interlocutory appeal on Jurisdiction, 2 October 1995, para 70

<sup>vii</sup> Observations report, US Department of State, Report to Congress on incidents during the recent conflict in Sri Lanka -2009

<sup>viii</sup> Between the United States and Prussia, 1785, Article XXII

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<sup>x</sup> Geneva Convention III, arts 25, 29, 97 and 108

<sup>xi</sup> Geneva Convention III, art. 49

<sup>xii</sup> Geneva Convention III, art. 88

<sup>xiii</sup> Geneva Convention IV, art. 97

<sup>xiv</sup> Common Article 3(1) 'shall in all circumstances be treated humanely'; Additional Protocol II, Part II contain this principle more than all this principle is a reflection of norm of customary law.

<sup>xv</sup> Prosecutor V Aleksovski, IT-95-14/1-A, Judgement, 24 march 2000, para 26

<sup>xvi</sup> AP II, Part IV, Article 3 (1)& 4(1)

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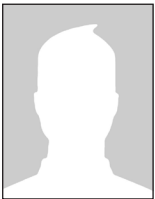
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# DECISIVE ROLE OF ROMAN LAW IN DEVELOPMENT OF INTERNATIONAL LAW

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**Abstract** – Roman Law has been generally conceived by legal academia as a system of private law, which mainly deals with contract, marriage and property. Though it has been not much widely discussed Justinian's "Corpus Juris" contains a good deal of Roman Public Law. The usage of this legal treatise was confined to Roman Empire and it was faded into oblivion by the decline of Rome in 5th century A.D.

The research problem of this research primarily deals with the fact that how Roman Law caused to create the pillars of International Law in the West and it further examines how Romans practiced customs with foreign nations and how those customs turned into be legal norms in coming years by making impacts to the development of International Law. The term Jus Gentium in Roman Law had a different meaning in practice. It designed primarily for the litigation among foreigners and in addition to that it was included rules of International Law such as sanctity of envoys or the captor's right to war booty.

In the post Roman era famous Jesuit scholar in Law Francesco Suarez (1548-1617) was the first modern jurist to apply "Jus Gentium" as International Law. Apart from that when Grotius developed the international law in 17th century his works were mainly influenced by Roman legal thinking. For instance the concepts of jus ad bellum and jus in bellum (Right to War) were developed under the thread of Roman notion of bellum justum (Just War).

The doctrinal approach will be applied to the assessment of this research on the basis of Roman legal texts and historiography. At the end of this work reader will get a clear understanding of how the modern roots of International Law were shaped through the annals of Roman juridical contribution.

**Keywords** - Roman Empire, Public Law, International Law, Just War

It is said Rome conquered world three times. Firstly from her armies, secondly through her religion (Roman Catholicism) then by her law. Indeed the legal legacy left by Roman civilization has made a profound impact in major legal systems in the world.

This paper intends to trace the historical contribution of Roman law upon the formation and development of International Law. In the legal academia general notion always has been to consider Roman law as a branch of Private Law which concerns property, contracts and family relations. But the practice of law by Romans had given so many contributions that firmly establish Roman law's dominance in the sphere of Public Law.

This paper comprehensively traces how Roman legal tradition had played a crucial role in carving the foundations of international law. Justinian's "Corpus Juris" contains a good deal of Roman public law which has left a profound impact upon the rise of absolutism in sixteenth and seventeenth centuries in England, but more importantly the uniqueness of Roman Law was virtually confined to the imperial domain of Roman empire.

In general overview Roman legal legacy has more precisely focused on its imperial position and internal standards, but there has been few significant factors made by Roman law with regard to the inception of modern international law. A systematic observation will be made in this paper to understand how Roman legal principles exactly influenced on construction of International Law as a norm in practice.

## I. LEGAL ELEMENTS IN ROMAN FOREIGN AFFAIRS

Corpus Juris has paid a less concern on the international affairs of the empire except the fact that it recognized the sanctity of envoys. In Rome foreign envoys were treated equally and harassing them was regarded as a violation of Jus Gentium. According to the historical writings of Pliny Roman Emperor Marcus Antonious had received a set of Sri Lankan envoys sent by King Bhatikabaya during Anuradhapura era. Both Sri Lankan and Roman sources have affirmed the Sri Lankan delegation was well received in Rome with proper manner. In fact treating foreign envoys respectfully was an unknown practice among Western nations in ancient era, especially even Greeks who were considered to be the champions of liberty and democracy had scornfully harassed foreign envoys in number of instances.

Though the Corpus Juris is considered as the prime text on Roman law, there are various rules in Roman municipal law on its international element. Indeed those standards had mainly emerged from the historical customs and various practices in Rome. The Law of booty of war could be taken as one instance. Under this law the captured objects were distributed by the government officials and one quarter of the captured property was sent to the national treasury. This practice was conceived as a common practice in the battle field and later it turned into be a part of Roman law. One of cardinal features of Roman international law was the formation of a group of religious priests known as Jus Fetiale, this group was responsible to administer religious ceremonials used in treaty making and military affairs. Furthermore during the Roman republic this religious body was entitled to decide whether Rome should go to war with foreign nations. It is true that Jus Fetiale was formulated within the municipal legal system of Rome, but it played a pivotal role in participating in the external affairs till end of Roman republic. In examining the process of how Rome involved in International Law during the Roman empire, it is an interesting factor to observe Rome frequently took part in treaty making. Most of those treaties were manifested a singular character. Today unequal treaty is a common

phase in International law and its inception technically dates back to Roman era. When the treaty making took place between Rome and a weaker nation. The weak party was compelled to accept the conditions made by Rome at any cost. These alliance were therefore called "Unequal Alliances" ( foedra enequa ). Under this Rome became the ultimate authority to set the rules of the treaty, especially the other party was subject to abide by the Roman conditions. In the same period of empire, Rome developed a practice of subjugating a conquered nation in a peculiar way.

This was known as "deditio". It was designed as a part of large body of Roman private law, whereas Roman administrator would ask the ruler of conquered nation for some preliminary statement and after receiving a satisfactory answer from them, the vanquished nation was further examined whether it is willing to transfer their citizens and properties to Rome. In the case of an affirmative reply Roman representative would declare his acceptance of the deditio. Though these treaties seemed to be unequal in its external nature, there was not entirely absence of equality element in some of their international treaties. As an example three times 509, 306 and 279 BC Rome had entered into treaties with Carthage.

They were mainly framed as commercial treaties and essentially different from the modern aspect of commercial agreements. Roman emperors sometimes signed treaties with foreign nations. The treaty between Roman emperor Marcus Aurelius and a German tribe in 175 A.D was the first event from the set of treaties in Roman history. Another peculiarity of Roman treaty law was the distinction drawn between an international agreement and its ratification, a prerogative of the Senate. If sworn to, the agreement as such gave rise in the Roman negotiator was extradited to the adversary." The rule, repeatedly followed during Republican times, was probably motivated by a desire to satisfy the gods invoked by the negotiator. In modern history of International Law, the term " Unequal Treaty " has been used as a phase to describe the treaties signed between Western powers with the Far Eastern States which were denied the reciprocal concessions. For instance the set of treaties took place between the British-French forces and Chinese imperial dynasty was

<sup>1</sup> DIGEST 50.7.18 (Pomponius), "Si quis legatum hostium pulsasset, contra jus gentium id commissum esse existimatur, quia sancti habentur legati."

<sup>2</sup> Smith Gerald, (1981), Roman power in Indian ocean, Universal law publishing house, New Delhi, p.54.

<sup>3</sup> Cyril Robinson, A History of Greece, (1919), Oxford University Press, London, p 213.

regarded as a typical unequal treaty. The treaty which was formulated between Rome and weak nations always shaped as unequal form whereas Rome always had the supremacy of making the treaty for her own good. The modern international legal concept "Sovereign Equality" was not a concern of the treaty makers in Roman Empire.

## II. THE BROADER INFLUENCE OF ROMAN LAW IN INTERNATIONAL LEGAL SPHERE

The real importance to Roman law in International Law emerged only with the formation of nation states in Europe. It was the practice of medieval ecclesiastical order in Europe to look for Corpus Juris as the guiding point of their municipal laws. As modern day scholar Andrew Borkowsky points out the second life of Roman law was begun after many centuries after the fall of Roman Empire from its earthly glory in 11th century A.D. The Europe was in many forms of chaos in the middle age. In fact the revival of Roman law in Europe was an offshoot of the excessive works of the commentators who were known as "Glossators". Italian cities like Padua, Bologna, Verona and Pavia became centers of learning in Roman law in the middle age where Glossators taught and worked on Roman law.

The uniqueness of Roman law's renaissance in Europe was, though the Justinian's code essentially focused on municipal laws such as contracts and obligations, its influence was expanded to a larger arena. As an example the Roman legal notions on personal laws were used in the international sphere as a remedy. In 11th Century Roman law held its helm in the entire territory of Holy Roman Empire and its impacts shaped the medieval legal thinking of Europe. In Rome the practice that existed relating to the affairs on foreigners was known as "Jus Gentium", but this term had a different legal significance.

Though primarily it was intended to the litigations among foreigners stayed in Rome, in a broader sense it meant the law common to all nations or for many nations. This attitude of universal nature caused in Roman Empire period to look at the issues like sanctity of foreign envoys in a more universal format. The famous Jesuit, Francesco

Suarez (1548-1617), was the first to see clearly that the term jus gentium had come in post-Roman times to mean two different things: (1) universal law and (2) international law (though the latter term and the present application of the first term are of later date); but he did not carry through his observation to the sphere of international relations. In this significance it has systematically. Only since Hobbes (1588-1679) has the phrase jus gentium been definitely confined remained popular up to our day though it is more and more being forced into the background by the term "international law" invented by Bentham in 1789.

It is true that Roman Law had conceived many concepts to the development of International Law and especially its understanding of Just War ( Bellum Justum ) has left a significant impact upon the the modern day evolution of laws of war. In the roots of Just War in Roman History it is a fact beyond dispute that it was imbued with the Christian theological understanding of war. According to the theological works of St. Augustine only the just war is permissible and even such a war cannot be begun out of greed for power or out of vindictiveness. This conception led its way to establish a firm legal justification on war in the middle age by another erudite Christian theologian Thomas Aquinas ( 1225-1274 ) who laid down three prerequisites of a just war. (1) The ruler's capacity to declare a war (2) Justa Causa or the good reason to doing so (3) recta intentio or a subjective righteous intent. Even after the collapse of Western Roman Empire these principles remained static in practice in European legal usage. As an example Romanization of European municipal laws by the commentaries of Glossators and canon laws did include the principle of " Bellum Justum " as an integral part of law. In the writings of jurists like Suarez, Ayalla and Belli, just war was taken up as a cardinal matter in both moral and legal perceptions. In the era of colonial expansion the just war was aptly used by colonial powers to uphold their hegemony over some inferior races. If war is conceived as a reaction of law against injury done, an investigation of the various kinds of injuries presenting a just cause for war is imperative. Such injury may consist in invading nation, etc. Hence the elaboration of the causes of just war will inevitably result in laying out a system of international law itself. This aspect of the just war doctrine is startlingly illustrated by the history of Byzantine and Russian civilization: there the just war idea was not adopted, and no conception of a law of nations was evolved. In examining the contribution made by Roman

<sup>4</sup> Andrew Borkowsky, Roman Law, (1994 ), Oxford University Press, London, p 123.

law to the development of International Law, it becomes an interesting factor to study that no state in Europe had adopted Roman legal principles into its international law approach than England. In English legal history the first clear indication of adopting Roman law dates back to Tudor era. Especially when Queen Elizabeth 1 ruled England some interesting remarks had made by Queen herself which verified the applicability of Roman law in international legal affairs in England.

For an instance when Spanish ambassador in Queen's court protested on Sir Francis Drake's naval exploration of Western Indies Territories, Queen's reply was "the use of the Sea and Air is common to all, neither can a title to the Ocean belong to any people or private person; for as much as neither Nature nor public use and customs permitteth any possession thereof". Indeed this position was a resemblance of Classical Roman Law on natural resources. As it was stated in Justinian's "Institute" "Roman Law had clearly admitted the no nation can claim the Ocean personally and it belongs to the entire humankind". UNCLOS (United Nations Convention on the Law of Sea) document has called high sea as common heritage of the mankind and navigation in the high sea has been regarded as an open act by the Law of the Sea itself. In English Court of Elizabethan era, the offence of piracy was plunder Spanish ships in high sea, but when it came to the court interpretation of English courts, judges of courts often used Roman legal principles on piracy. As an example in the writings of Cicero during the considered a criminal act though Queen personally patronized those prominent pirates like Walter Ralley, Francis Drake to classical period of Roman Law, Cicero had insisted piracy as a grave crime and the same dictum had been descended upon the courts in 16th century England. There is another salient historical illustration from English legal history which would demonstrate how Roman "Jus Gentium" Law of Nations infiltrated into the practice of diplomacy in Tudor court. When in 1584 Spanish ambassador was charged for treason, English government approached a jurist called Gentili at Oxford who held the chair of Civil Law at that time. Gentili argued according to law of the nations (International Law in modern terminology) England could do nothing except to expel him. Though England had not totally adhered to Roman law as its common law, in order to decide the Anglo-Spanish relations English finally opted for Roman

law as the decisive factor. In such an event England could not be harsher to Spanish ambassador except banishing him. Even till now the Vienna Treaty of 1966 has ensured safe passage to the diplomats even in the circumstances of treason. It could be just to assume the deeply rooted influence of Roman law has caused the foundation of diplomatic protocols of modern world to include sense of civility in its affairs.

Historically no other country had relied on Roman law in the international legal sphere than Holland. In 1599 when Holland detached from Spanish influence, its general assembly applied the principles of Justinian as the "Common law of nations" against the Spanish blockade. The Dutch law giver Grotius who is considered to be the father of International Law had often referred to Roman legal principles in his legal treaties. With the emergence the great codifications towards the turn of 18th and 19th century, the authority of Justinian's legislation began fast to recede. With this background Roman law was assimilated into the domain of public law in Europe.

## II. CONCLUSION

Generally modern international law owes a heavy conceptual debt to the Roman law. For instance number of terms in modern international law has derived from the Roman legal terminology with different meanings. The expression of state servitude emerges from Roman "servitude" and its modern interpretation essentially focuses on rights of the passage and similar enactments confining the ownership of a parcel of land. Apart from that terms such as occupation, assertion, have referred in Corpus Juris with different annotations. The legal usage for occupation in Roman law was the appropriation of things which is movable or immovable, belonging to no one. But the same term has been borrowed from Roman law to international law with a different usage, whereas occupation is used to the seizure of enemy territory or a territory not yet under a sovereign. In today's application of international law, one cannot exactly point out to which extend Roman law has directly expanded in the domain of international law.

Because mainly the fragments of Roman legal principles have been superseded by the modern needs and they rather have been modified or improvised. The above mentioned terminological usage borrowed from classical Roman law

<sup>5</sup> Martin Jerome, *Augustine and his world*, (1945), Pelecan books, London, p 34.

<sup>6</sup> Richard Mclavain, *Political works of Tudor rulers*, (1918), Cambridge University Press, p34.

<sup>7</sup> James Crawford, *Creation of States in International Law*, (1989), Oxford University Press, p 234.

is an ideal example for it. The statement made by US legal historian Arthur Nussbaum in an article would be an appropriate phase to epitomize and evaluate the historical significance of Roman law on coining the modern foundation of international law. He states “Perhaps all this

does not amount to very much, but it means at least that in some places Roman law served to fasten the shifting sands of international law. The historic significance of Roman law is far greater; it was an indispensable tool in the early development of a doctrine of international law.”



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# ANALYSIS OF DEPENDENCIES & LEGAL BARRIERS ON DIGITAL FORENSIC INVESTIGATIONS IN SRI LANKA

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**Abstract** - The objective of this research is to investigate dependencies and legal barriers arises when conducting digital forensic investigation in Sri Lankan context. Since the Sri Lankan legislations on computer crimes are now outdated and were written before the era of computer forensics, computer forensics experts face major problems during computer forensic investigations. Due to this issues, lot of court cases were delayed for over years and still open for interpretation.

To firmly analyse this prevailing issue, Evidence (Special Provisions), Electronic Transactions Act, Payment Device Fraud Act, Computer Crime Act and Mutual Assistance in Criminal Matters Act were analysed against the basic digital forensic process (acquisition, preservation, analysis and presentation). Empirical evidences form digital forensic engineers were also gathered using questionnaires. Seven issues were recognized during this research and they are, Cross Jurisdictional Conflicts, Cloud Computing Challenges, Need of National Certification Authority, Need of Legally Accepted Forensic Software Tools, Stored Communication, Anonymization and Technical Competencies of digital forensic experts.

These issues were discussed in detailed with the appropriate recommendations and suggestions to improvements. New domains of forensics analysis which need to be included in the current legislative system were also discussed during this research. By referring this research, computer forensics experts would be able to identify techniques to produce legally admissible evidences to the courts.

**Keywords** - Digital Forensic Dependencies, Legal Barriers on Digital Forensic, Sri Lankan Legislations on Digital Forensic Investigations

## I. INTRODUCTION

Information and communication technologies (ICTs) are changing societies around the world improving productivity in traditional industries, revolutionizing labor processes and remodeling the speed and flow of capital (UN, 2005). This change also reflected in Sri Lanka during the past two decades and at the same time adoption of the ICT has shown a rapid growth. Failure to safeguard electronic data in motion, in processing and in stored has arisen considerable amount of computer related crimes in Sri Lanka. This includes, but not limited to fraud, hacktivism, identity theft and unauthorized access. However, when conducting a digital forensics investigation on such computer based criminal activities, computer forensics experts face many forensics dependencies and legal barriers due to ambiguities exists in current Sri Lankan legislative system. In order to preserve, collect, recover, analyze and present digital evidence to courts, computer forensics experts need to follow proper legal procedures enforced by the legislative system, however current Sri Lankan legislative system does not provide necessary legislative powers and technical frameworks required by computer forensics experts to continue with their investigations. This research is based on finding out such legal barriers and forensic dependencies and to discuss the areas which need to be revised in the current legislative system.

### A. Research Problem

Digital forensic experts face numerous dependencies and legal barriers when producing and presenting legally acceptable evidences to the courts due to the poor support and provisions provided by the current Sri Lankan

legislative system. As a result, a number of court cases were delayed over several years, remained as un justified and still open for interpretation.

**B. Research Objectives**

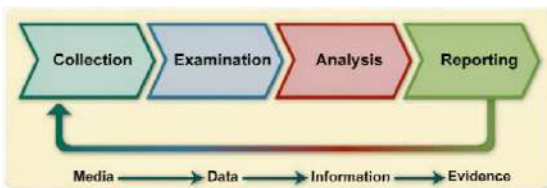
The main research objective is to identify dependencies and legal barriers on digital forensic investigations in Sri Lanka.

This research contains following sub objectives as well.

- 1) To identify the areas which are not covered by the Sri Lankan legislations on digital forensic analysis.
- 2) To discuss the ways which Sri Lanka can obtain international support and assistance to collect evidences located in foreign countries.
- 3) To examine areas which need to be introduced to address current requirements in digital forensics analysis.
- 4) To provide suggestions and recommendations on the main research objective.

**C. Literature Review**

As defined by McKemmish (McKemmish, 1999) Digital Forensics is the process of identifying, preserving, analyzing and presenting digital evidence in a manner that is legally acceptable. Definition given by the McKemmish is further strengthened by Farmer & Venema (Farmer & Venema, 2001) by explaining digital forensic as Gathering and analyzing data in a manner as free from distortion or bias as possible to reconstruct data or what has happened in the past on a system.



**Figure 1: Digital Forensic Investigation Process**

According to the description given by the United States Computer Emergency Readiness Team (US-CERT, 2008) Digital Forensic Investigation is the ‘The discipline that combines elements of law and computer science to collect and analyze data from computer systems, networks, wireless communications, and storage devices in a way that is admissible as evidence in a court of law’. As explained

by the McKemmish, Identification, Preservation, Analysis and Presentation are the four major steps involved in Digital Forensic Investigation as illustrated in figure 1. In Sri Lankan context, mainly necessary powers and grants to conduct digital forensic investigations is provided from the Evidence (Special Provisions) Act (No. 14 of 1995) and from the Computer Crime Act (No. 24 of 2007) of Sri Lanka. The Evidence Act provides necessary procedures to obtain legally admissible evidences during a digital forensic investigation.

**II. METHODOLOGY**

Collecting secondary data was the first step of this research. The Researcher has gone through all applicable legislations on this research topic to build up a proper understanding of applicable laws and regulations on Sri Lankan context. Several international conventions on cybercrime along with their publications and policy documents were also referred. Meanwhile similar research and publications done in the similar domain were used to find out the current research gap between Sri Lankan legislative system and legislations used by other nations.

To collect the primary data mainly questionnaires were used. This is because, The Researcher has understood that, to gain further understanding of the research problem, it is mandatory to identify the dependencies and barriers faced by the digital forensics experts and legal personal (Ex. Lawyers, Judiciaryes). To collect personal opinions and personal experience on the research question, The Researcher has interviewed several information security experts to collect qualitative data. Digital forensics experts and judicial officials were selected as the target population for collecting primary data.

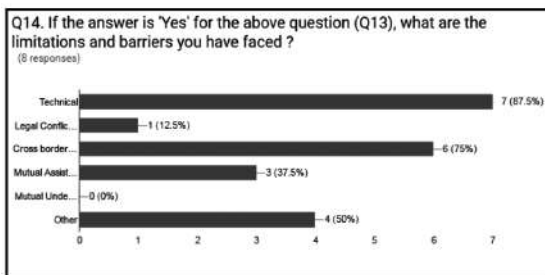
**A. Data Analysis Methodology**

First of all, The Researcher has gone through the collected secondary data to identify key areas that causes forensic dependencies and legal barriers. Then Researcher has interviewed the Principal Information Security Engineer at Sri Lanka Computer Emergency Readiness Team (Sri Lanka CERT), Eng. Roshan Chandraguptha (Chandraguptha, 2017) to acquire additional impression on prevailing issues on the research problem. Feedbacks from the questionnaire were analyzed to confirm that issues identified by the Researcher is also exists with the digital forensic experts. Furthermore, from the explanation provided by digital forensic experts during the questionnaire, The Researcher has found additional areas on the research problem.

### III. RESULTS

By analyzing responses for the questionnaire from 10 digital forensic experts, following dependencies and legal barriers were recognized.

1. More than 90% digital forensic experts answered that they are facing issues when obtaining an information relevant to forensics investigation from foreign nations.
2. More than 75% of experts highlighted that they are experiencing Cross border legal conflicts (between other nations).
3. More than 90% of digital forensic experts highlighted that there is a need of National Certification Authority (NCA) for Sri Lankan context.
4. 50% of security professionals uses an open source digital forensic investigation software and remaining security professionals use both commercial and open source software.
5. More than 50% digital forensic experts emphasized that 'Preservation' of the data is the most difficult phase in computer forensic investigation.



**Figure 2: Survey Response for obtaining an information relevant to forensics investigation from foreign nations**

Based on the interview had with Eng. Roshan Chandraguptha (Chandraguptha, 2017), following issues were also recognized.

1. Timely access to the service records, logs and stored communication owned by the service providers.
2. Anonymized communication.
3. Lack of technical competencies of digital forensic experts.

### IV. DISCUSSION

This section elaborates identified dependencies & Legal Barriers on Digital Forensic Investigations with relevant recommendations.

#### A. Mutual Assistance with Foreign Nations

The Researcher understood that without having a proper diplomatic and cooperative arrangements with peer nations, when conducting a forensic investigation, it impossible to obtain all necessary and required information. Different legislative systems available in peer nations would act as a legal barrier which will hinder the continuation of a forensics investigation. The section 35 (1) of the Computer Crime Act of Sri Lanka, provide guidance to adhere with the 'Mutual Assistance in Criminal Matters Act of Sri Lanka', when seeking an assistance to obtain information relevant to a particular forensics investigation.

The method of getting assistance relating to the taking of evidence, statements, the serving of process and the conduct of searches are mentioned under the section 35 (2) and (3) of the Computer Crime Act. According to the section 4 of the Mutual Assistance in Criminal Matters Act of Sri Lanka, the secretary to the ministry of the minister in charge of the subject of justice shall be the Central Authority. According to the section 8 of the same act, The Central Authority has given with the permission to seek the assistance required on identifying and locating evidences and suspects located in foreign nations. However, when dealing with other nations the powers granted to the Central Authority is not sufficient to conduct forensic investigations due to the cross-jurisdictional conflicts. Cybercrime cases that demand cooperative mechanisms that are not provided for within existing legal instruments create significant difficulties for police and prosecuting agencies (ITU, 2012).

In order to collect electronic evidences from the sources which are located outside of Sri Lankan geography, it is an essential to have a strong collaboration among international law enforcement entities. To establish such strong collaboration among such entities like Interpol, Europol, Council of Europe (CoE), European Union (EU), United Nations (UN) and Budapest Convention, the Sri Lankan legislative system need to be timely updated. This international level collaboration need to be establish at the diplomatic level with mutual understanding with the other nations.

This collaboration should not be limited to gather evidences, but this should also need to be support to find, trace down and prosecute suspects who resides in a foreign nation. The Researcher has observed that recently, Government of Sri Lanka has become a fully-fledged

member of the Budapest Convention on Cybercrime. This action will help to overcome cross-jurisdictional conflicts for upcoming legal cases. The Budapest Convention is the first international treaty seeking to address internet and computer crime by harmonizing national laws, improving investigative techniques, and increasing cooperation among nations (Chandrasekara, 2015).

**B. Need of National Certification Authority (NCA)**

According to the section 7 and 8 of Electronic Transactions Act, No. 19 of 2006, there is a legal recognition for electronic signatures as well as Use of electronic records and electronic signatures in Government institutions and statutory bodies. Unlike signatures used in physical document to verify the authenticity, digital document needs to be digitally signed to verify the authenticity. Once the electronic document is digitally signed, the signee cannot be denying that he/she haven't signed that electronic document. As per the section 7 and 8 of the act, electronic documents which are digitally signed authenticated traded as legally admissible evidence(s). As per the section 8 (2) (C) all digital signatures used to sign the electronic documents need to be issued by a Certification Authority (CA) or Certification Service Provider. The task of a certification authority is to issues and maintain the lifecycle of a digital certificates which can be used to sign the electronic documents and verify the authenticity of a person or an entity.

Currently, there is no national level certification authority to issue and maintain digital certificates on behalf of Government of Sri Lanka (GOSL). Therefore, individuals and commercial organizations practices digital certificates issued by the 3rd party CAs which are situated outside the Sri Lanka. VeriSign (VeriSign, 2017), Thawte (Thawte, 2017) and Comodo (Comodo Group, 2017) are most common 3rd party certification authorities used in Sri Lanka.

The problem arises when the authenticity of a Sri Lankan entity is being verified by a 3rd party Certification Authority which is belongs and located in a foreign country. As an example, to verify the authenticity of the website of the Parliament of Sri Lanka, it uses digital certificate issued by a 3rd party certification authority called DigiCert (DigiCert, 2017) as illustrated in the figure 3. In such scenario, the validity of the digital certificates and digital signatures are highly questionable.



**Certificate Information**

**This certificate is intended for the following purpose(s):**

- Ensures the identity of a remote computer
- Proves your identity to a remote computer
- 2.16.840.1.114412.1.1
- 2.23.140.1.2.2

\*Refer to the certification authority's statement for details.

**Issued to:** \*.parliament.lk

**Issued by:** DigiCert SHA2 Secure Server CA

**Valid from:** 2/ 2/ 2016 **to** 2/ 8/ 2017

**Figure 3: Digital Certificate issued to Parliament of Sri Lanka by digicert CA**

The Electronic Transactions Act, No. 19 of 2006 does not have any clause to verify the authenticity of the digital certificates used by the non Sri Lankan certification authorities. Even though the section 18, 19 and 20 of Electronic Transactions Act clearly defines the requirements, establishment process and powers of a Certification Authority, currently there is an absence of national level root certification authority. This absence becomes a huge barrier to verify the authenticity of an electronic document, data message or an electronic record in order to provide legally admissible evidences to the courts.

As a solution, Information and Communication Technology Agency (ICTA) of Sri Lanka is currently in the process of implementing National Certification Authority. The Electronic Transaction Act, No. 19 of 2006 has given the provisions of setting up a Certification Authority, which will act as the National Certification Authority (Root CA) of Sri Lanka and hence accreditate and regulate the certification service providers (certificate service providers/issuing CAs) addressing the requirement of the country. Information and Communication Technology Agency (ICTA) of Sri Lanka has been designated as the Certification Authority for the purposes of the above act by the gazette notification on 24th September 2013.

**C. Challenges with Cloud Computing**

Researcher understood that more and more organizations and individuals are relying on cloud computing services to host their services, application and data. This proliferation

of cloud computing has brought many challenges to forensic investigators as they rarely have physical access to the underlying infrastructure (Lopez, et al., 2016). Even though the Sri Lankan entities including government organizations are now stores their data in cloud storages and cloud services, the judicial system is unprepared to prosecute and investigate cloud based crimes.

The key legal issue with the cloud computing is the ownership of the data stored in the cloud. Even though the ownership of the data belongs to Sri Lankan an entity, the data is physically stored in someone else's datacenter. Unlike traditional digital forensics methods, cloud forensics presents a unique challenge due to the omnipresent nature of 'the cloud'. The National Institute of Standards and Technology (NIST) defines Cloud Computing Forensic Science as "application of scientific principles, technological practices and derived and proven methods to reconstruct past cloud computing events through identification, collection, preservation, examination, interpretation and reporting of digital evidence" (NIST, 2014). The amount of data these cloud providers have from their clients is a very desirable objective for criminals. Additionally, hackers can use cloud computing as a platform to distribute malware, conduct scams and perform other criminal activity. Thus, investigating cloud related crimes is an arduous but essential task in order to bring criminals to justice (Lopez, et al., 2016).

As most of the cloud service providers store their data in different data centers across the globe, the key challenge is to find 'in what datacenter does your data lives?' The headquarters of the cloud service provider may be in a one country and its data centers may be located in different countries. Therefore, the question 'when your data is truly scattered across numerous servers, how do you determine which jurisdiction applies? (Ex. which state court do you rely on to issue subpoenas, file a civil suit, etc.)' (Willson, 2013) need to be properly answered.

When it is required to obtain data from a cloud service provider, the data must be preserved until it can be lawfully acquired. Preservation is an essential tool in electronic discovery, particularly with highly volatile and elastic data (Dykstra, 2013). The discovery of electronic evidences during forensics investigation can be cumbersome, however with the support of the legal system we can make the preservation and extraction lot easier.

As a solution, Government of Sri Lanka can impose regulation on government entities and Sri Lankan citizens for store their organizational and confidential data on Lanka Government Cloud (LGC). LGC is fully owned by the Government of Sri Lanka and operations and governance is done by the Information and Communication Technology Agency (ICTA) of Sri Lanka. Since LGC is within the Sri Lankan geography, by nature, it will adopt all applicable legislations and therefore it is possible to conduct any type of computer forensic without any legal and technical barriers.

#### **D. Legally Accepted Forensic Tools & Software**

Forensics software and tools being used to automate the forensic analysis process and to extract data quickly than traditional methods. The science of digital forensics is founded on the principles of repeatable processes and quality evidence (Brunty, 2011). Therefore, Forensic software and tools must provide its results without modifying or altering existing data on the data sources. Modification done to the original sources of data will results integrity issues which leads to invalidate the output of such software. According to the definition provided by the NIST, 'digital forensics test results are repeatable when the same results are obtained using the same methods in the same testing environment' and 'digital forensics test results are reproducible when the same test results are obtained using the same method in a different testing environment' (Brunty, 2011). Moreover, such tool would be able to gather, authenticate and verify the evidences in a sound manner while assuring that the original media is not altered. It should also need to maintain the chain of custody by maintaining the media, documents, and evidence related to a forensic case under the custody of the authoritative personal.

Forensic Toolkit (FTK) (AccessData, 2017), EnCase Forensic (Guidance Software, 2017) and Helix Enterprise (e-fense, 2017) can be named as the major commercial forensic analysis software used in the Sri Lankan context. Apart from commercial software, there are open source software as well. Autopsy® (Carrier, 2017), SANS Investigative Forensic Toolkit (SIFT) (SANS, 2017) and Computer Aided Investigative Environment (CAINE) (CAINE, 2017) are the most commonly used open source alternatives.

However, current Sri Lankan legislative system does not define what are the software tools which need to be used to produce legally admissible evidences to the courts. In some

countries, legislations accept only the reports and evidences produced using commercial forensic software and does not admit the reports and evidences produced using open source forensics software. However, some countries accept reports and evidences from either commercial, open source or custom software designed by the forensics expert as long as the expert can justify the validity of the evidences to the courts. The Researcher recommends that to use commercially available and internationally recognized software and tools like Forensic Toolkit (FTK), EnCase Forensic and Helix Enterprise, because evidences and reports generated from commercial software are accepted in most other nations. Furthermore, it will help to avoid cross jurisdictional conflicts when conducting international level digital forensic investigations since most of the foreign law enforcement authorities accepts evidences from commercial forensic software.

#### **D. Stored Communication**

Preservation of data is the most important thing in stored communication. The preservation period of the information will differ from service provider to a service provider. Since most of the service providers do not have huge infrastructure to save all the communication details, most of the times they only keep stored communication data for several days. Preservation of stored communication is an essential part to protect the integrity and accuracy of evidences. Since the amount of days which service providers need to keep their communication information is not defined by the current legislation, most of the times when a investigation is carried out, relevant information might not be exists. This became a huge barrier to obtain relevant even after a few weeks from the date which the incident has occurred.

The Researcher, highly recommends that, for regarding IP addresses, SMS transactions, call logs and VPN tunnels, service providers need to retain information which can contains the user information for a considerable amount of time. The Researcher suggests that, such data need to be retained for at least period of 6 months, since normal court case would take about 6 months to resolve. However, as per the Australian Attorney General's department, Australian service providers need to retain their subscriber data along with their transactions for a minimum of 2 years (Government, July 2015). according to Eng. Roshan Chandraguptha (Chandraguptha, 2017), retaining data for 2 years is fairly expensive for a country like Sri Lanka. Therefore, his recommendation was to have a retention period of 3 months.

#### **D. Anonymization**

Anonymization is a technique used by the cyber criminals to hide their identity and cover their tracks. They are well aware about the normal situation, therefore they use sophisticated steps to hide their individuality. Anonymization techniques are specially crafted to conceal a user's identity when navigating the Internet or sending communications (Morris, 2004). Cybercrime offenders also exploit proxy servers to conceal online activity (Spence, 2003). Proxy services enable users to establish a connection to a network via an intermediary server. Common proxy servers can be configured for access control, caching services, and enhanced information security (Brown, n.d.). Furthermore, Virtual Private Networking (VPN) is another source for anonymization. VPN traffic is always encrypted and would not be able to intercept by other parties. Even for a digital forensic investigation, this traffic cannot be decrypted without having the required private or public Keys.

It is technically impossible to find out the content of anonymized traffic flow. Therefore, digital forensic experts would not be able to extract evidence out from anonymized traffic. The only possible answer is to filter out all the data traffic which comes in and out to Sri Lanka. However, such mechanism is costly and hard to implement. Therefore, this issue is beyond the control of legislations of Sri Lanka. The only step that legislation can perform is, block the access to the internet and VPN services. As an example, the authorities in China have intensified their crackdown on VPNs, internet connections that bypass the country's firewalls and online censorship (Jing, 2016).

#### **E. Skills & Technical Competencies of a Digital Forensic Experts**

Due to the growth of technology, the current measures used for finding cyber criminals and collect digital evidences are not sufficient. Therefore, digital forensic experts need to update their technical competencies more often. Methodologies which have been used to prosecute cyber criminals before 5 years are not applicable now and many cybercrimes are now sophisticated and well-conceived, requiring police to apply technological expertise and deductive reasoning to unravel complex 'modus operandi' and substantiate elements of an offence (Bromby, March-July 2006).

In most of the cases digital forensic experts will be the first responders to a computer crime incident. Therefore,

they need to possess with good technical skills and good leadership skills to obtain digital evidences at the crime scene. Seasoned leadership is required to effectively direct investigations and supervise the provision of forensic support (Horswell, 2004). However, competencies and skills required by first responders are not specifically mentioned in current Sri Lankan legislative system. According to the section 17 of the Computer Crime Act, ‘any public officer having the required qualification and experience in electronic engineering or software technology’ is defined as a forensic expert. Researcher strongly believes that the same set of skills needs to be acquired by Sri Lankan digital forensic expert to be an expertise in digital forensic domain. According to Brown (Brown , 2015), following set of hard and soft skills (illustrated in table1) need to be possessed by a digital forensic expert. The Researcher strongly believes that the same set of skills needs to be adopted by first responders and forensic experts.

**Table 1: Soft Digital Forensics Investigative Skill Sets**

HARD SKILL	SOFT SKILLS
Research	Communicative
Awareness	Rational
Evidence Continuity	Collaborative
Forensic Imaging	Intuitive
Networking Architecture	Coherent
Hardware	Resilient
File Systems	Punctual
Structured Data Analysis	Fastidious
Unstructured Data Analysis	Disciplined

## V. CONCLUSIONS AND RECOMMENDATIONS

The Researcher has understood that it is too difficult to make modifications to the current legislative system and the changes should come from the top level governors of Sri Lanka. The Researcher recommends following high level modifications for the current legislative system.

1. Mutual Assistance in Criminal Matters Act (No. 25 of 2002) need to be updated to get assistance in obtaining digital evidences from a sources located in foreign nations. This should need to include assistance on preservation of data and obtain the preserved data.
2. Evidence (Special Provisions) Act (No. 14 of 1995) need to be modified to cater to the modern requirements of collecting digital evidences. Further, it need to be revised to support to collect evidence for foreign nations as well.
3. Government of Sri Lanka need to focus on establishing the National Certification Authority (NCA). This is to provide digital identity to Sri Lankan citizen where they can use their digital identity on the day to day electronic transactions and to sign digital documents. This will provide better traceability on evidences and offenders.
4. Government of Sri Lanka needs to focus on establishing a National Security Operations Center (NSOC) where security related incidents can be monitored real time. This will allow digital forensic experts to obtain necessary source and destination IP data along with data traffic information.
5. Act on real-time monitoring and interception of data traffic which empower police and security agencies to obtain court orders to intercept communications between computers in urgent and exceptional cases.
6. Act to access encrypted data which is in stored or in motion. This is to extract evidences from a sources where data are archived or stored with strong encryption.
7. Set of rules and regulations to keep the chain of custody during digital forensic investigation. This need to be included with instructions on digital crime scene processing and digital forensic services.
8. Need to define what are the competencies and skills need to be acquired by digital forensic experts and what are the legally acceptable digital forensic analysis software and tools.
9. Proper definition of who is a ‘digital forensic expert’ (this is because, Computer Crime Act defines Forensics Analyst form a government university as an ‘expert’, where Payment Devices Fraud Act defines Forensics Analyst from Sri Lanka CERT|CC as an ‘expert’). Furthermore, role of digital forensic experts need to be introduced to Government Analyst’s Department.
10. Being a Commonwealth country, Sri Lanka needs to enter into the convention of ‘Commonwealth Model

Law on Computer and Computer Related Crime’ in order to get the mutual and legal assistance to gather digital evidences during a forensic investigation as well as to prosecute cyber criminals.

**ACKNOWLEDGMENT**

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# ILLEGAL UNREPORTED UNREGULATED FISHING BY SRI LANKAN FISHERMEN: LAW IMPLEMENTATION MECHANISM AND FISHERS' ATTITUDES ON COMPLIANCE

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**Abstract** – This paper discusses the mechanism of the national legal framework for combatting IUU fishing and suggests strategic improvements based on fishers' attitudes on compliance. A questionnaire was prepared and forwarded to the legal department of the Department of Fisheries and Aquatic Resources (DFAR) to get an insight on the current law implementation mechanism to combat IUU fishing at national level. A separate questionnaire was forwarded to groups of fishermen in Kudawella, Dondra, Kalpitiya and Cod-Bay fishing harbors to observe the level of their attitudes on compliance. Fisheries and Aquatic Resource Act No 2 of 1996 is the main legal instrument that regulates fishing operations in the Sri Lankan EEZ. No 35 of 2013 amendment and certain extraordinary gazettes assert the rules for fishing operations in the high seas.

Push net, moxy net, monofilament net, gill net and trammel net on coral reefs have been pronounced as illegal fishing methods in Sri Lanka. High seas fishing operations are monitored by Vessel Monitoring Systems (VMS) and log books. (VMS), catch data regulations, and high seas fishing operation regulations are among the major regularity measures.

There are awareness programs organized by the DFAR to enhance the level of awareness of fishermen on compliance. Poaching of Sri Lankan fishermen in other countries EEZs could be limited, due to the availability of

new technological and navigational equipment to identify the position of the boats. However, the number of cases of violations has been increased within the last three years.

In 2015, Sri Lankan export fisheries were banned by the EU, due to the records of IUU fishing by Sri Lankan fishermen. Miscommunication and unawareness of fishermen, unavailability of sufficient VMS systems, lack of proper mechanism for making complains and technicality of the compliance procedure may hinder the expectations of effort to combat IUU fishing. Increased number of VMS boats, onboard inspectors, enhancing the communication between fishermen and the DFAR are viable solutions to increase the level of compliance. Poaching of Indian fishermen in Sri Lankan EEZ is a major threat to the sustainability of fish stocks in the areas under national jurisdictions, which needs proper monitoring and surveillance to control.

**Keywords** - IUU fishing, law implementation, compliance

## INTRODUCTION

Fishing industry is a growing business that is very important to supply animal protein to world's growing population. It provides numerous direct and indirect occupations while enhancing the opportunities of trade related income

generation. With the increasing demand for fish products, there is a huge pressure put on wild catches, questioning the sustainability of the future fish stocks. IUU fishing has been identified as a major threat for marine ecosystems, food security and sustainable fisheries around the world (NOAA Fisheries, 2012). Due to this reason, combating IUU Fishing has become a high priority in international fisheries management protocols (De Gallic & Cox, 2006). Fishing activities that dissident national, regional, or international conventions or management measures are defined as Illegal Unreported and Unregulated fishing (IUU). It can be further elaborated as follows. (Department of Fisheries and Aquatic Resources, 2013; International Plan of Action to prevent, Deter and Eliminate IUU Fishing (IPOA-IUU) 2001)

**Illegal fishing:** fishing activities that contravene the national and international laws that applicable to the fishing areas (especially in high seas). It includes fishing without license, under-reporting catches, keeping undersized fish, using prohibited fishing gear types, illegally transshipping fish etc.

**Unreported fishing:** fishing activities that has not been reported or properly reported. It is associated with poor data collection or weak fisheries management and lack of reporting.

**Unregulated fishing:** fishing activities in areas where there are no applicable national, regional or international conservation or management measures. It is associated with unmanaged fishery activities within a country's Exclusive Economic Zone (EEZ) or in the high sea, and fishing done by vessels that are un-flagged or flag of convenience.

Most South Asian and Southeast Asian countries are regular poachers in unmonitored fishing grounds (Vasan, 2017) and the case of IUU fishing by Sri Lankan fishermen drew the world's attention when the European Union imposed a ban on Sri Lankan fishery products in 2015 for over one and half years as Sri Lankan fishermen were accused of engaging with IUU fishing in the high seas. Sri Lanka is the second largest fish exporter to the European Union with major export products of fresh tuna and chilled swordfish. Lack of declared legislations to combat IUU fishing in the high seas made the EU not to purchase fish products for one and half years. This drastically decreased profits of fish exporters and many fishermen even lost their jobs. Lost profits were especially recorded for multiday boats, which use long lines and

other gear that target skipjack tuna and yellow fin tuna. The ban was lifted after implementation of the high seas fishing operation regulations as an amendment of the Act No 35 of 2013, which enforced the rules and regulations in the international and fascicular contracts signed by the Sri Lankan government. Department of Fisheries and Aquatic Resources (DFAR) is the responsible authority to prepare the rules and regulations for fisheries management at national level. Other than that, they organize programs to improve the awareness of the fishing community on the need of sustainable and responsible exploitation of fisheries resources. In natural resources management, acquiring the grassroots support and the knowledge of local people shall not be underestimated and shall be integrated and balanced with the top-down regulatory measures in order to achieve better management (Nevil, 2004). Therefore attitudes and awareness of fisher communities on rules and regulations for preventing IUU fishing shall be clearly understood for implementing effective fisheries management measures. The objective of this paper is to look in to the national law implementation mechanism to combat IUU fishing and suggest better strategies to improve it based on the fishers' attitude on compliance

## 2. METHODOLOGY

A questionnaire was prepared and forwarded to the legal department of the Department of Fisheries and Aquatic Resources (DFAR) to get an insight on the current law implementation mechanism to combat IUU fishing at national level

A separate questionnaire was forwarded to fisher communities in Kudawella, Dondra, Kalpitiya and Cod-Bay fishery harbours (Trincomalee) to observe the level of their attitudes and awareness on compliance. The questionnaire forwarded to the DFAR was answered by its legal officer. Sixteen (16) fishermen were randomly selected at each harbour location to carry out the survey. Data was interpreted using Microsoft Excel software

## 3. RESULTS

Law implementation structure with regards to combating IUU fishing at national level

As a signatory to the United Nations convention of the Law of the Sea (UNCLOS, 1982), Sri Lanka is obligatory to ensure proper conservation and management measures of the living resources in the EEZ and the high seas, taking the best scientific evidences. Implementation of the rules

and regulations for preventing IUU fishing is under the authority of the Department of Fisheries and Aquatic Resources (DFAR) of The Ministry of Fisheries and Aquatic Resources Development, and National Aquatic Resources Research and Development Agency (NARA) supports the DFAR with scientific facts and evidences regarding fish stocks. Fisheries and Aquatic Resource Act No 2 of 1996 is the main legal instrument that asserts the rules and regulations for all fishing operations in the Sri Lankan Exclusive Economic Zone (EEZ). No 35 of 2013 amendment of the Act and the gazette of the Democratic Socialist Republic of Sri Lanka (extraordinary) dated 2014.9.01, 2015.03.03, 2015.03.26, 2015.10.26, 2015.12.14, specially assert the rules for fishing operations in the high seas. As some additional instruments, Chank regulations and lobster regulations assert the rules for coastal chank and lobster fisheries.

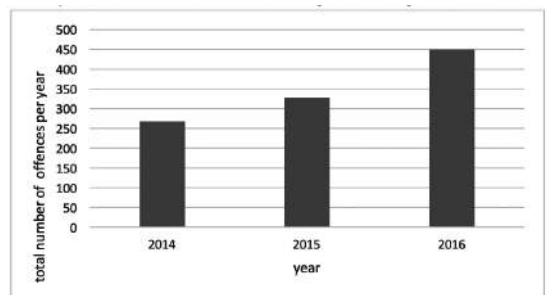
Fishing methods of push net, moxy net, monofilament net, gill net and trammel net on coral reefs have been pronounced as Illegal fishing methods in Sri Lanka. Fishing operations in the EEZ and high seas are regulated and controlled by Vessel Monitoring Systems (VMS), and catch data regulations (use of logbooks). VMS and logbooks in multiday boats are supposed to facilitate monitoring and proper reporting of fish landings. VMS system uses satellite-based communications from on-board transceiver units, which certain vessels are required to carry. The transceiver units send position reports that include vessel identification, time, date, and location, and are mapped and displayed on the end user's computer screen.

Each vessel sends its position once in every four hours. When it moves out from the EEZ of the country, vessel-monitoring center in the Ministry of Fisheries and Aquatic Resources warns that boat to return. VMS also helps fishermen when they are in distress. Catch data regulations require fishermen to maintain a logbook during fishing operations and feed the information with daily catch data of a fishing trip. It includes the date of net setting, setting position (latitude & longitude) size of gear, number and weight of fish caught. (Pink color sheet for purse seine net, green color for gill net, white color for long line). Under high seas fishing regulations, the vessels fishing in the high seas require licenses for the boat and for the skipper. This was imposed after the EU ban of Sri Lankan export fisheries in January 2015, which drastically decreased profits and many fishermen lost their jobs. Monthly meetings and training programs are conducted by the DFAR to build awareness among fishermen on

responsible fishing. The Navy, the Air Force, and the Coast Guard play a major role in monitoring and surveillance of vessels operated in Sri Lankan waters.

Poaching of Indian fishermen in Sri Lankan EEZ is another major threat to the sustainability of national fisheries resources. Indian poachers use dynamite fishing, bottom trawling and other illegal fishing gears and according to the Immigration Act, the government commute the fishermen without serious sanctions. .

However, regardless of these efforts, number of offences with regards to IUU fishing has been increased within last three years. Offences of using illegal fishing methods such as purse seine, and monofilament nets are significant during 2016.



**Figure 1; violation of Fisheries and Aquatic Resource Act no 2 in 1996**

The role of fisheries inspectors is very significant, as they are the responsible officers to check the fish catches to ensure whether they meet the approved standards.

Attitudes and Awareness of fisher communities on regulations to combat IUU fishing

Out of all the fishermen, who were interviewed, 63% had at least once been to other countries EEZ for fishing before regulations being introduced and 6% have been arrested. “Diego Garcia” is a popular area where they used to fish regularly. All multiday boats have new technological navigational equipment such as VMS, GPS and radio, which makes it easy to identify the position of the vessels. 44% of the visited boats in the survey had VMS installed. In multiday boats, logbooks are maintained to record catch data.

DFAR organizes training and awareness programs for fisher communities on sustainable exploitation of fishery resources. The 60% responded that they are willing to participate in those programs, but do not regularly get a free time. That is mainly because they are fishing in the high

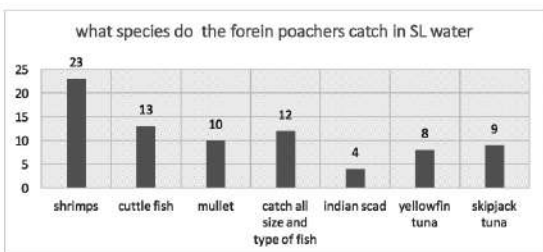
seas at the time that the programs are being held. Fishermen face many problems because of the miscommunication between them and fishing inspectors. Fishermen have to spend lot of time to fill their documents, which they see as a trouble for their job. 75% of the interviewed fishermen have problems with recording the catch data. Some of them are illiterate and their knowledge is insufficient to fill logbooks, while operating new equipment such as VMS can be too technical for them.

82% of the interviewed fishermen responded that there is a reduction of fish catches compared to previous times. As for them, increased number of fishing boats, trawling by Indian fishermen and usage of course nets are among the major suspected reasons for that.

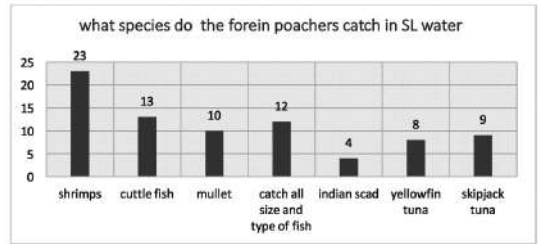
**Poaching of foreign fishermen in Sri Lankan Waters**

73% of the interviewed fishermen claimed that they have seen foreign fishermen (48% very often) in Sri Lankan waters. According to them, these foreigners catch mostly shrimps, cuttlefish, and all sizes and type of fish using trawlers. 67% claimed that that they see them as a threat for their job. Because they catch all sizes and type of fish and it decreases local fishers' target fish catch and profit. It was revealed that foreign fishermen damage the gear and boats, which belong to Sri Lankan fishermen.

Fishermen in Trincomalee and Kudawella and Dondra fishing harbors responded that they have no proper procedure to complain poaching incidents. 63% of them are not satisfied with the attention paid by the DFAR, the Navy or the fisheries inspectors on this matter. 13% responded that they do not attempt to make complains anymore even though they witness foreign vessels fishing in Sri Lankan waters. But the situation in Kalpitiya was different. 100% responded that whenever they make a complain, the Navy takes proper actions to check and arrest the vessels.



**Figure 2. Fishing gear that Indian fishermen use**



**Figure 3. Fish species that Indian fishermen catch.**

**3. Discussions and Conclusion and Recommendations**

Top down management might not show successful results all the time. The most effective management strategies may surface from the community, the true resource owners. In this bottom up management approach, it is very necessary to understand the level of understanding of the community on the resources and incorporate their suggestions to make it more adaptive. The most effective management approach shall reach the correct balance between both top down and bottom up strategies.

Miscommunication and unawareness of fishermen are the main challenges, which hinder the effective compliance on the law implemented by the DFAR. Some simple techniques such as SMS alerts can be used to notify the date of awareness programs in advance and permitting the fishermen to adjust their working schedules at a prior time can be very effective.

There shall be a better reporting system for all fishermen, which is easy to understand and use. New technologies shall be introduced, which is capable of automatically calculating the catch data and transfer the information at the fishing harbour, where fishermen come with the catch. Decreasing fish stock is a threat for fishing industry. To increase the abundance of fish stocks, identification of the grounds suitable for growth of fish and stock enhancement activities are important. Innovative gear technologies, which allow undersized fish to escape and chasing away non-targeted species are vital to preserve depleting fish stocks.

It was revealed that there are 4800 multiday boats in Sri Lanka, but only 1536 have been installed with VMS. Measures shall be taken to provide VMS to all multiday fishing boats to facilitate effective reporting mechanism. Proper mechanism for taking complains on IUU fishing shall be established and fishermen shall be informed how to make a complain immediately after witnessing an IUU incident. Navy and Coastguard patrol officers shall

be well aware of their duties with clear understanding on how IUU fishing adversely impact on marine ecosystems. Introducing on-board fisheries inspectors to enhance the monitoring capacity is another way of combatting IUU fishing in the high seas.

Poaching of Indian fishermen is a main threat for national sustainable fishery approaches. Government must understand the situation and take actions to follow proper procedure to prosecute the guilt and order sufficient penalties to discourage any future IUU attempt. .

All these regulatory efforts are only applicable in the EEZ and in the high seas. Fishing operations in the coastal waters are not being considered under this regime. There is no mechanism to monitor fisheries activities in coastal waters, which needs immediate actions taken.

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# THE NEED FOR A REGIONAL MECHANISM TO COMBAT PIRACY AT SEA IN THE SOUTH ASIAN REGION.

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**Abstract** - This research paper explores whether there is a need for a regional mechanism to combat piracy in South Asia with special reference to Sri Lanka. Thus, the objectives of this paper revolves around identifying whether there is a need to implement a regional anti-piracy mechanism, its practicality and the challenges that has to be faced if such regional mechanism is to be introduced. The methodology adopted in this paper is a comprehensive analysis of available literature on the matter of global piracy and regional mechanisms.

The Literature review explores using available statistics if there is an urgent need for a regional mechanism to combat piracy in South Asia. It draws the attention to successful regional mechanisms of other regions of the world. It will also briefly look in to the subject matter with the standpoint of benefits to Sri Lanka if such a mechanism is implemented. The results and analysis of available statistics indicates that the number of pirate attacks in the Indian Ocean especially near India and Bangladesh mainly, is increasing though the past decade. This may be due to a spill over effect from the piracy hotspot in the Southeast Asian region like the Malacca strait.

Even though the countries of the South Asian region are part of the regional agreement known as the Regional Cooperation Agreement on Combating Piracy and Armed Robbery against Ships in Asia (ReCAP) for all Asian countries, it is observed that they need a sub-regional mechanism that is sensitive to the geographical, political, economic concerns of the South Asian region. In conclusion it is evident that there appears to be a need to form a regional mechanism to combat piracy in the South Asian region. This could be achieved through the existing institution for regional corporation namely South Asian Association for Regional Co-operation (SAARC).

**Keywords** - Piracy at Sea, Piracy in South Asia, Regional anti-piracy mechanisms

## I. INTRODUCTION

With the rapid globalization process there is an expansion of the needs of the people and trading economies. The world has become linked through land, air and sea routes. Many of the world's goods are transported through sea routes and piracy has become a global threat not just in the modern era but also from ancient times.

One of the first international instruments and corporation came about to eradicate piracy and slavery in the world. Pirates were considered to be enemies of mankind under Customary International law. But for many centuries after those collaborative efforts piracy is threatening global stability and economies. Abductions, deaths, violence and damage to maritime vessels force all states to wake up from their slumber and take definitive action against combating piracy. As a result many international instruments<sup>1</sup> and regional instruments<sup>2</sup> establishing regional corporation mechanisms took birth.

The United Nations Convention on the Law of the Sea 1982 in Article 101(a) defines piracy as; "Any illegal acts of violence or detention, or any act of depredation, committed for private ends by the crew or the passengers of a private ship or a private aircraft, and directed on the high seas, against another ship or aircraft, or against persons or property on board such ship or aircraft as well as against a ship, aircraft, persons or property in a place outside the jurisdiction of any State"

It further states that any act of voluntary participation in the operation of a ship or an aircraft with the knowledge

that it is a pirate ship or aircraft also includes an act of piracy.

This research paper explores whether there is a need for a regional mechanism to combat piracy in South Asia with special emphasis on Sri Lanka. Thus the objectives of this paper will revolve around identifying whether there is a need to implement a regional anti-piracy mechanism, its practicality and the challenges that has to be faced if such regional mechanism is to be introduced.

## II. METHODOLOGY

The literature research method was adopted in this paper. This paper focuses on a comprehensive analysis of available literature on the matter of global piracy and regional mechanisms. The Literature review explores using available statistics whether there is an urgent need for a regional mechanism to combat piracy in South Asia. It draws the attention to successful regional mechanisms of other regions of the world. It will also briefly look in to the subject matter with the standpoint of benefits to Sri Lanka if such a mechanism is implemented.

## III. RESULTS AND DISCUSSION

Safe sea routes are vital not just for economic expansion but also for the safety of citizens of various states who are engaged as crew members of sea vessels. Piracy has evolved in to a global threat fought with violence and advanced technology.

There are different organizations which were established to prevent, report, reduce and combat international piracy. International Maritime Bureau (IMB) and the International Maritime Organization (IMO) IMO are two such organisations which are concerned with the issue of piracy. It should be noted that the two organisations define piracy in dissimilar ways. The International Maritime Organization is a body under the United Nations (UN), and it has adopted the definition of piracy from the United Nations Convention on the Law of the Sea (UNCLOS)<sup>3</sup>. According to Amri (2004) the definition itself is quite narrow and defines some illegal activities at sea to be ‘piracy’.

The International Maritime Bureau is established as a part of the International Chamber of Commerce (ICC) but the IMB’s definition is broader and covers almost all attacks against ships in all maritime jurisdictions of a state (Amri, 2004). Under the broad definition given by IMB, an act committed by the crew/ passenger of the ship to board or attempting to board any ship together with the motive to commit theft or any other crime should be present. But not only that, there should be an attempt or capability to use force in furtherance of that act (Abhyankar,1999).

In the Code of Practice for the Investigation of Crimes of Piracy and Armed Robbery against Ships of the International Maritime Organisation (IMO) Assembly Resolution A.1025(26) armed robbery against ships is defined as;

1. Any illegal act of violence or detention or any act of depredation, or threat thereof, other than an act of piracy, committed for private ends and directed against a ship or against persons or property on board such a ship, within a State’s internal waters, archipelagic waters and territorial sea
2. Any act of inciting or of intentionally facilitating an act described above.

According to the statistics offered by the International Maritime Bureau (ICC International Maritime Bureau, 2016), the Somali pirates had launched 237 attacks near the coast of Somalia in 2011 alone indicating the gravity of the situation at hand.

According to Brandon (2000) as cited by Bulkeley (2003) “ninety percent of the world’s trade moves by ship, one-third of the world’s shipping moves through Southeast Asia’s waters, and 65% of all pirate attacks in 2000 occurred in Southeast Asia”.

Therefore the South East Asian region has piracy hotspots like the Malacca strait which is the strait that joins the South China Sea with the Indian Ocean. It is one of the main sea routes of the cargo ferrying vessels in Asia. According to the report for the first quarter for the year 2016 of the IMB (ICC International Maritime Bureau,

<sup>1</sup> The United Nations Convention on the Law of the Sea of 1982

<sup>2</sup> For an example regional instruments include the ASEAN Declaration on the Prevention and Control of Transnational Crime which mentions piracy as a transnational crime, the Regional Cooperation Agreement on Combating Piracy and Armed Robbery in Asia of 2004

<sup>3</sup> United Nations Convention on the Law of the Sea, Signed 10 December 1982 in Jamaica



2016) high numbers of piracy for that quarter could be observed near India and Bangladesh in the South Asian region.

When comparing these data with the statistics available from 2011 (1st quarter) the piracy attacks both attempted and actual have increased dramatically near India.

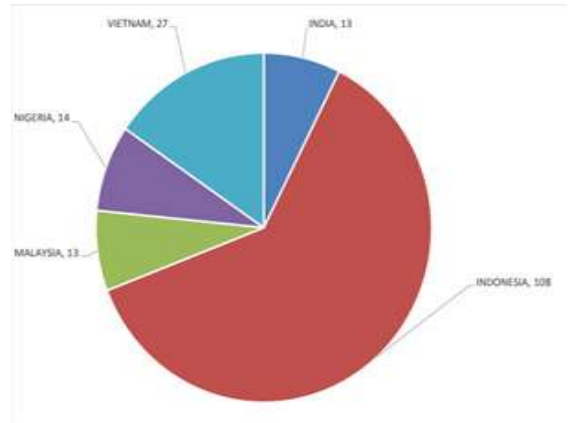
**Locations of actual and attempted attacks in the first quarters (January – March) of 2011 – 2016**

	2011	2012	2013	2014	2015	2016
Indonesia	5	18	25	18	21	4
Malaysia	9	2			3	
Philippines	1	2	1		2	2
Singapore Straits	4	2	2	5	2	
South China Sea	4		1			
Vietnam	2	3	1		8	2
Bangladesh	4	3	4	4	1	
India	3	3	4	2	2	10

**Table I- ICC- IMB Piracy and Armed Robbery Against Ships Report – First Quarter 2016.**

In the first quarter of 2016 the highest number of locations where piracy attacks took place as per this report is India and Nigeria. The number of attacks (10 attacks) near India exceeds the sub total of the attacks made near other countries in the Asian region. Bangladesh too shows a consistent pattern of attacks until 2015. Thus we can safely assume that the high levels of piracy in the Malacca strait may have a spill-over effect to the Indian Ocean. Two thirds of the total 37 attacks within this period can be attributed to locations near the countries of India, Indonesia and Nigeria.

According to the ICC- IMB Piracy and Armed Robbery Against Ships Annual Report for 2015 during the whole period of 2015 71% of the total of 246 reported incidents could be attributed to Indonesia, Vietnam, Nigeria, India, and Malaysia.



**Chart I- ICC- IMB Piracy and Armed Robbery Against Ships Annual Report for 2015.**

In India, Sikka and Kandla ports frequently reported piracy attacks in port and anchorage areas. In Bangladesh as per the report (ICC International Maritime Bureau, 2016) indicates that robbers usually target ships preparing to anchor and most attacks were reported at Chittagong anchorages.

The main two types of ships that were attacked during 2016 were tankers carrying chemical products and Bulk carriers.

It is a notable fact that the attempts to capture crude oil transporting vessels has diminished greatly but the threat still remains. Thus it indicates that piracy can affect negatively to trade and commerce directly affecting the economies of States.

In 2015 in India, a total of three incidents were reported near the port of Sikka and in the Kandla port six cases of incidents were reported (ICC International Maritime Bureau, 2015). Chittagong port in Bangladesh reported 10 incidents of piracy for the full year of 2015.

The above statistics clearly indicates that South Asia too has been significantly affected by this global piracy threat and some form of collective action is needed to ensure that the threat does not reach proportions that cannot be handled by the countries.

It is easily understandable how Asia is targeted by pirates. One third of the world’s shipping moves through the Strait

of Malacca and the Singapore Strait. Most trade between Europe and China, and nearly all the crude oil that moves from the Persian Gulf to the big Asian economies like China, Japan and South Korea. It was calculated that a ship enters the Malacca strait every four minutes and it is in certain locations the strait is only 1.7 miles wide (Kemp and Trythall, 2014)

### **A. Regional Instruments and Cooperation**

However there are many regional instruments that States have ratified in view of eradicating piracy. The Regional Cooperation Agreement on Combating Piracy and Armed Robbery in Asia of 2004 also known as the “ReCAAP Agreement” is a fine example for this. Almost all the Asian states signed this regional agreement and it established the Information Sharing Center known as the “ReCAAP ISC”. However since its inception it has not successfully managed to reduce notably the problem of piracy in the Asian waters.

The Southeast Asian countries being the countries that are one of the highest reported piracy attacks through their regional association ASEAN have taken steps to combat piracy even though they are part of the larger cooperation agreement for Asia known as the ReCAPP Agreement.

This has led to a decrease in the number of attacks or rather number of successful attempts at piracy. Even though they were part of a larger agreement for Asia the Southeast Asian countries has formed their own sub-regional mechanism because each region has region-specific factors that has to be addressed giving attention to them in particular.

This leads the South Asian countries to the significant milestone or point of decision making to seriously consider whether they should adopt sub-regional (for the South Asian region) mechanism to strengthen their capacities to combat piracy.

As pointed out earlier in the discussion there is a tendency to have a spill-over effect from the piracy hotspots in Southeast Asia to the Indian Ocean. When this happen the eight South Asian countries (India and Bangladesh in particular) are at risk. Compared to the other countries with a strong sub-regional mechanism like in the Southeast Asian countries the South Asian countries lack expertise in combating piracy simply because it had not been a huge threat over the past few decades.

The recent trend in the gradual increase in the number of attacks in the Indian Ocean forces the South Asian countries to re-think their strategies in this regard. Since many of these countries are developing countries of the third world they have to engage in some sort of a regional corporation mechanism to ensure that they have and share enough resources, expertise and technical support.

### **B. Practical dimensions of having a regional mechanism**

This endeavor of achieving regional cooperation may prove to be indeed difficult. Especially when taking in to consideration the regional political power play. For an example India and Pakistan is in a conflict situation over Kashmir. Sri Lankan and Indian(the southern India including Tamilnadu) relations are tense over the ethnic conflict, illegal fishing in territorial seas and the island of Kachchathivu. Afghanistan which is a recent addition to the South Asian countries is also unpredictable due to the nature of the internal politics and wars. India when it comes to naval power has a higher bargaining power than her neighboring countries and may over shadow the other States.

With all of these in mind it should be noted that achieving regional corporation is not impossible and a good example for this is the South Asian Association for Regional Cooperation (SAARC).

This regional cooperation has undertaken many regional endeavors and attempts that are progressive and beneficial to the region such as; the South Asian Free Trade Area (SAFTA) which removed trade barriers to increase the level of economic cooperation, energy cooperation, initiation of Integrated Programmes of Action (IPAs) for areas like Agriculture, rural development, human resources development etc. It is evident that SAARC is expanding its scope from a regional mechanism that mainly focused on political and economic cooperation to that which encompasses cultural and social dimensions of the region as well.

### **C. Impact on Sri Lanka**

Sri Lanka is not without a threat in the aspect of pirate attacks. For an example the recent Comoros-flagged oil tanker that was captured by Somali pirates in March 2017 had eight Sri Lankan crew members. This is the first such attack of a large commercial vessel off Somalia since 2012 (The guardian, 2017). Even though the crew was released

without ransom through negotiations it is a clear eye opener that Sri Lanka should take preventive measures and establish mechanisms to address the issue of piracy.

During the 1900's Sri Lanka had the largest floating dock in Asia which was situated in Trincomalee and it is still known as one of the deepest ports in Asia. Sri Lanka is slowly expanding its ports and the recent addition of a port in Hambanthota also indicates that there will be an increase in the number of ships that comes to its harbors.

The harbor in Hambantota is situated in the locality of many international marine lanes where nearly 2,000 ships move along every day. It is an excellent port for bunkering of ships. Through these recent expansions of harbours sea trade can be improved drawing more and more ships to the ports. Thus it is imperative that Sri Lanka takes positive steps to address the issue of piracy.

There are several key benefits that Sri Lanka will gain if such a regional mechanism is implemented. One such benefit is that since Sri Lanka does not have sufficient expertise in this field, a regional mechanism will ensure shared expertise of professionals in the field.

Through a regional mechanism it is not just professional consultations that could be received but also the sharing of advanced technology could be achieved and this could be a highly beneficial aspect for countries that are comparatively poor in terms of finances and technological equipment within the South Asian region.

A country cannot carry out piracy eradication operations alone simply because of the vast ocean area that has to be covered. Thus when a regional mechanism is established they can share human resources and the moment a pirate attack is notified the country/navy which is closest to the ship can take immediate action.

A regional mechanism will ensure proper flow of information between different governments and their naval forces. They can establish regional information centers that monitor and evaluate pirate activities within that area. Countries like Sri Lanka could extremely benefit from the strong naval power offered by regional power blocks such as India.

A regional instrument/treaty could be brought in to affect that sets out the responsibilities, duties, obligations

and jurisdictional matters with regard to such a regional mechanism.

### III. CONCLUSION

It is evident from the above discussion that there appear to be a need to form a sub-regional mechanism to combat piracy in the South Asian region. This could be achieved through the existing institution for regional corporation namely South Asian Association for Regional Co-operation (SAARC).

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# TO WHAT EXTENT THE PROTECTION OF INTELLECTUAL PROPERTY RIGHTS ARE INVOLVED IN 'BIO PIRACY' IN SRI LANKA

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**Abstract** - Bio piracy could be identified as the process of claiming patents to restrict the general use of exploited plants and animal species for the purposes of bio prospect. This process is interrelated to the principle of intellectual piracy which the world considered it as an international principle to be applied irrespective of the different protections provided under the Domestic Law. The Agreement on Trade Related Aspects Of Intellectual Property Rights (TRIPS), as the international legal framework which provides standard for the intellectual property right has created a conflict of interests among developed and developing countries, with regard to the protection of biological resources and traditional knowledge of countries.

The main objective of this research is to analyze the misappropriation of the propriety right by the developed countries over the biological resources in the developing countries, special reference to the Sri Lankan context, within the framework of TRIPS.

The research problem is to identify the contentious discard between the International Laws and Domestic Laws in relating to protection of intellectual property rights involved in 'Bio Piracy' in Sri Lanka and how such dissension of laws has created the conflict between environmental interests and economic interests of the country. This research will also analyze the legal and practical issues relating to implementation of both domestic and International Laws in protecting the intellectual rights of biological resources in Sri Lanka.

The research also would engage in analysis of the provision of TRIPS Agreement which have created serious challengers relating to the rights in area of bio diversity in Sri Lanka and how such provisions have exceeded the applicability of relevant domestic legal regime.

Moreover, the focus of this research would also include the significance of developing a sui generis system to protect the intellectual rights of biological resources in Sri Lanka, with the objective of critically analyzing of how to develop a domestic legal framework which amalgamate with the TRIPS Agreement .

The research methodology of the research would involve the legal research methodology and it is based on qualitative data obtained by primary sources including statutes, international instruments and constitutional provisions. The secondary sources of law which involve in the research will be scholarly articles and text books.

**Keywords** - Bio Piracy, genetic resources, intellectual Property rights

## I. INTRODUCTION

The main objective of this research is to analyze the involvement of the intellectual property rights in 'Bio Piracy' in Sri Lanka and to what extent such rights are involved in protecting the biological resources and the traditional knowledge of the country. The research problem is to identify the issues of misappropriation of intellectual property rights by the developed countries over the biological resources and traditional knowledge of developing countries within the legal framework imposed by the TRIPS Agreement; and special reference will be given to Sri Lanka as a developing country.

The one of the main objectives of this research is to examine on how developed countries have claim ownership and unfair advantage over the biological resources and traditional knowledge in developing countries within the framework of TRIPS, though the domestic legal regimes of developing countries have imposed laws to restrict

such intellectual property rights up to certain extent. The research would also engage in analyzing existing legal framework of Sri Lanka with regard to the protection of intellectual property rights of biological resources and how such regimes are ineffective in the application of practical scenario.

## II. BIO PIRACY

Bio Piracy is the process of which corporations from the industrialized nations claims ownership of, free ride on, or otherwise take unfair advantage of the genetic resources and traditional knowledge and technologies of developing countries (Calan.N,2006). Specifically, Bio Piracy could be identified as process which gain the exclusive monopoly rights over the biological resources or traditional knowledge one country by another representatives institutions of another country. The demand for the genetic resources have increased, as a result of the development of biotechnology in different aspects. 'Bio Piracy' is a major problem is faced by the countries rich in bio diversities. Further the main purposes of the Bio Piracy could be recognized as intention of introducing new plant varieties and living organisms, privatization of traditional knowledge and production of pharmaceutical products. Moreover Bio Piracy is consisted of two main phenomenons, namely the genetic resources bio piracy and the traditional knowledge bio piracy.

As mentioned above the developing countries with rich bio diversities are fairly the repercussions of bi piracy and it has become a serious threat to the biologic resources of such countries (Brooks et.el,2002). Further the one of major aspects at bio piracy could be identified as the process of exploring commercially valuable, biological resources and it is directly linked with the markets for patent commodities in various industrial sectors (vandana,1997). However the main objective of the bio prospecting is commercializing the biological resources while the globalization of Intellectual Property Rights regimes has created the platform to the people who bio prosepct to expand their economic interests.

The impact of Intellectual Property Rights regime over the biological resources, in developing countries could be analyzed under different legal regimes. The Trade Related Aspects of Intellectual Property Rights Agreement (TRIPS) is a multilateral agreement introduced by World Trade Organization (WTO) and it provides high minimum standards for the intellectual property rights of

the countries bound by the agreement. In the perspective of protection of Intellectual Property right of biological resources or genetic resources of countries, the TRIPS Agreement is consisted of provisions for the protection of new plant of varieties as a major part of the biodiversity of a country. However the provisions of the TRIPS agreement which, allow patenting the live forms could be recognized as a factor encourages the bio piracy. Therefore certain restrictions or boundaries should be implemented to prohibit patentingng plants, natural resources, animals, microorganisms and it is required to promote the sustainable use of biological or genetic resources in order to prevent bio piracy.(Malik,2003). There are many instances for well-known bio piracy incidents, like patent obtained by American Companies for turmeric grown in South Asia and periwinkle grown in Madagascar.

However bio piracy is a process with profitable nature and its economic objectives have become major threat to the developing countries due to the exploitation of bio resources and disadvantage of cultural social and health of human life. Thus the inadequacy of the protection for the biological resources has expanded the process of bio piracy and also the legitimacy of the component of TRIPS Agreement has challenged (Khor, 2002). However there is direct impact of bio piracy over Sri Lanka as a country with rich bio diversities and also being member of WTO, the obligation to implement the provision of TRIPS agreement with in the country has created several negative impacts on the development of the country.

## III. INTERNATIONAL LEGAL REGIME PERTAINING TO BIO PIRACY

The International legal regime pertaining to bio piracy could be examined under a comparative analysis, as the international laws relating to bio diversity before 1994 were differed from the existing legal framework. Earlier, the utilization of the natural resources by researchers, private organizations, scientists was justified based on the concept of common heritage of mankind.

However, the implementation of certain laws and principles imposed by the international conventions, in order to enhance the protection of bio diversity in the world, have changed the practices of people towards the ulitization of the biological resources for various purposes. The convention on Biological Diversity (1994) could be

identified as land mark mechanism which was established by the authorized international community, in order to conserve the biological diversity in the world.

This convention is not the first international treaty which addresses the conservation of species and habitats, but it is the first to address conservation of all biological diversity worldwide with the concept of sustainable utilization of such resources (Rosendal 2013). Among the provisions of the convention which set restrictions for the biopiracy, the article 3 and 8 (j) are significant. Accordingly, those articles emphasize the sovereign right of a country to exploit the own resources pursuant to their own environmental policies and to ensure that such activities do not causes damages to the environment of other states or the areas beyond the national jurisdictional limits. Apart the above mentioned two main articles, there are other relevant provisions of the convention linked with the legal framework which confronts the concept of biopiracy.

However, the most significant issue which requires to consider under this convention, is the continuous debate of the effects of Intellectual property rights imposed by the TRIPS agreement on the achievement of the objectives of the convention on Biological Diversity. Therefore, it is required to review the linkages between Intellectual property rights and the conventions' objectives, while highlighting the controversy. The intellectual property rights which have implications for the objectives of the convention on Biological Diversity could be analyzed under four main areas. One such area is the affect of TRIPS agreement on the access to genetic resources and fair and equitable sharing of benefits arising from such resources utilization which is guaranteed under the Article 15 of the convention of Biological Diversity.

The objectives of the convention will be achieved only if intellectual property rights holders guarant the fair and equitable sharing of benefits of the genetic resources they have already accessed. However, it could be identified that, the intellectual property rights permitted by the TRIPS agreement may undermine the possibility of ensuring the equitable sharing of benefits for the countries which utilize such resources for various purposes. In addition individuals and organizations, use these intellectual property rights permitted by the TRIPS agreement as a tool to restrict the sharing of benefits gained by using the genetic resources of a particular country.

The second controversial factor of the linkage between the intellectual property rights and the objectives of the

convention of Biological Diversity, is the negative affect of intellectual property rights over the preservation of the traditional knowledge of indigenous and local communities. Specifically, the grant of patents, is a major factor which encourages the individuals and corporations to misappropriate the traditional knowledge. This uneasy relationship between the intellectual property rights and conventions' objectives could be recognized as a subject with much debate.

The third aspect of the relationship between intellectual property rights and the objectives of the convention on Biological Diversity could be recognized as the, TRIPS agreements' affect on the transfer of technology. It is significant to analyze on how intellectual property rights affect the categories of development of technologies, either the technology developments gain directly from the use of genetic resources or the development of technology for the purposes of conservation and sustainability of the relevant resources.

However the market oriented intellectual property rights are mainly focused on promoting the economic value of the genetic resources, while giving less focus on the benefits of the developing countries that provide access to such resources.

The second set of issue related to the impact of TRIPS agreement on transfer of technology included in the objectives of the conventions, is the effect of intellectual property rights on the tranfer of technology to developing countries based on fair and equitable terms which guaranteed under the Article 7 and 66 of the TRIPS agreement. However, the role of intellectual property rights in technology transfer is complex, and empirical research is limit and largely inconclusive. ( US council for TRIPS 1999).

Moreover, the fourth area which requires to analyze under the linkage between intellectual property rights and the objectives of the convention, is the intellectual property rights which affect the conservation and sustainable use of biological diversity described under the Article 15 of the convention. The contribution of intellectual property rights towards the conservation of biological diversity requires more exploration, as the economic incentives linked with the intellectual property rights regime encourages the genetic use of restriction technologies.

However, the above mentioned controversial debate between the objectives of the convention on Biological

Diversity and the intellectual property rights demonstrates that, though the convention imposed legal framework to protect and preserve the biological diversity in the world, the intellectual property rights regime permitted by the TRIPS agreement as an international legal instrument, have created certain escape clauses to the biopiracy under different perspectives.

Specifically, this controversial debate among the two legal regimes should be analyzed with in the context of Sri Lanka, as a country legally obliged to both international legal frameworks. In addition , the International treaty on plant Genetic resources for Food and Agriculture (2001), The Paris convention, The International Undertaking on plant Genetic resources and the Union for the protection of New Plant varieties could be recognized as the some of other significant international instruments which aim to protect the biological diversity from the biopiracy threats.

#### **IV. SRI LANKAN LEGAL REGIME PERTAINING TO BIO PIRACY**

The existing laws relating to the Bio safety of Sri Lanka could be analyzed under different perspectives and the identification of gaps available with in the domestic legal framework, which have serious impact over the biodiversity of the country is significant. Despite the various statutes available for the protection of biological resources with in the country, the constitution of Sri Lanka plays major role in imposing the fundamental laws to the environmental protection. For examples, the Article 27(14) which safeguards the protection and preservation of the environment for the benefit of the community and Article 28(f) emphasizes the duty of every person to protect the nature and conserve riches of the environment could be identified.

However, the adequacy of the existing laws for the protection of biodiversity in the country has subjected to many criticisms, due to the practical issues relating to the protection against the biodiversity of the country. The one such major reason affects on biopiracy, is the absence of sui generis system with in the country. Among the existing laws against bio piracy, the protection provided through the intellectual property rights regime need to be examined.

The analysis on the intellectual property rights regime in the domestic context will be provided a platform to a compartive analysis with the intellectual property rights permitted by the international legal regimes.The

Intellectual Poperty Rights Act No 36 of 2003 provides laws relating to the intellectual property in Sri Lanka. The intellectual property rights relevant to biological resources dealt with the granting of patents under the Part 4 of the Act and specifically, these patents rights ensure the protection of intellectual property rights of the genetic engineering techniques and their products. The granting of patents described in the Act, requires three main elements to be satisfied. According to the sec 63 of the Act, an invention is patentable, if it is new, involves an inventive step and industrially applicable.

Except the patentable inventions, there are some inventions which could not be patented under the sec 63 of the Act, though they have acquired the three required elements for such grant of patent.

The inventions which excluded from granting patents could be identified under the sec 62(3) of the Act. Specifically, under the excluded categories of inventions from granting patents, the biological process for the production of plants and animal is excluded. However, the granting patents for the genetic engineering technology is not excluded. Therefore, the granting of patents for the all genetic engineering technologies is accepted in Sri Lanka.

This exclusion of inventions which cannot be patented will not be applied for the genetic engineering process and according to the sec 63 (3) (b) , no animal or plant, except a transgenic micro organisms could be patented in Sri Lanka. These prohibitions are major steps taken by the Act to restrict the activities relating to bio piracy process. Moreover, the sec 63 (3) ( f) of the Intellectual property Act has expanded the scope of intellectual property rights regime by granting discretionary power to Intellectual Property Office to decide the acceptance or refusal of granting patents for certain inventions.

This discretionary power of the authority will protect the public order and morality from the damages which may cause due to harmful inventions. Despite the Intellectual Property Rights Act, there are other statutes relating to the matter of biopiracy, like Fauna and Flora Protection ordinance (1937), National Heritage and Wilderness Areas Act (1937), Plant Protection Act (1999) and Water Hyacinth ordinance (1909) are few of such existing laws for the biosafety in Sri Lanka.



## V. CONFLICT OF INTERESTS

The conflict of interests relating to the bio piracy could be recognized as the non compliance of certain elements between the TRIPS agreements and the Intellectual Property Act (2003), in the protection of the biological resources. As a member of World Trade Organization (WTO) , Sri Lanka is obliged to implement the legal framework provided by the TRIPS agreement. Thus, the obligation imposed by the TRIPS agreement upon Sri Lanka has created conflict between the economic interests and environmental interests of the country. Therefore, it is important to identify the instances where these interests are contradicted and the legal aspect which make such non compliance of interests.

The major controversial issue between the international and national laws is based on the plants variety protection and , the Article 27 of the TRIPS agreement deals with the subject matter of this debate. According to the Article 27 of the TRIPS agreement, the protection could be given to inventions of all field of technology , and Article 27 (3) (b) provides an exclusion for the patents protection of plant varieties. However, this exclusion would be permitted, only if a member country provide an effective sui generis system for the plant variety protection. This article elaborates the exemptions of granting patents for plants and animals, though the restrictions have been made for granting patents for biological resources in the same provision.

Thus, the individuals or corporations of developed countries who intends to accomplish economic interests by using the biological resources in the developing countries, have ability to achieve their objectives, by applying this exemption permitted by the TRIPS agreement. However, it could be recognized that the developing countries will not find protective place within the framework of the TRIPS agreement.

Therefore , the plants ,animals should not be patented and the bio piracy should be prohibited by promoting alternative attempts to conserve the genetic materials. (Millett 1999). Sri Lanka as a developing country lacks a sufficient legislation with regard to the Article 27(3) (b) of the TRIPS agreement and it affects to increase the activities relating to bio piracy.

## VI. CONCLUSION AND RECOMMENDATIONS

As a developing country, Sri Lanka has no sufficient legal framework to safeguard its biodiversity from bio piracy, which mainly occurred due to the exemptions permitted by the TRIPS agreement.

Therefore, it is important to establish a sui generis system which compliance with the TRIPS agreement in order to protect the biological resources from the bio piracy. However, it could be recognized that , implementing sui generis system in a developing country is defective in many aspects, due to their less practicability. There are recommendations in relating to the prevention of bio piracy in developing countries, which could be implemented by promoting certain changes in the TRIPS agreement.

The revision of the requirements described in granting patents applications in order to ensure the prevention of misappropriating genetic resources and the benefits sharing gain from biological resources , is one such recommendation. Further, the requirement of expanding the exceptions to grant patents under Article 27 (3) (b) of TRIPS is another fact which WTO should be considered. Moreover , more flexibility should be given in defining the sui generis system of developing countries which protect their economic and social interests.

These recommendations may enhance the efficiency of intellectual property rights involve in biodiversity protection and they will play accurate role in preventing the bio piracy in the developing countries.

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# A GRAPPLE FOR STANDING OUT RATHER FITTING IN: SRI LANKAN CLAIM TO THE COMMISSION ON THE LIMITS OF THE CONTINENTAL SHELF

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**Abstract** - Continental shelf is one of the maritime zones which consist of numerous rich mineral deposits, oil, gas and fisheries. The commercial value attached to this particular zone is gigantic. In consequence every state tries to extend their continental margin in order to exploit and grab as much as they can make out of it.

A state is entitled to establish their outer edge of the continental margin by two ways. One is Article 76(4) of the Law of the Sea Convention (LOSC) 1982 which cannot be utilised to claimed more than 200nm and the second is by Statement of Understanding (SOU) contained in annex 2 to the Final Act of the 3rd UN Conference on Law of the Sea 1980 which entertain claims of the states having special geological and morphological characteristics.

Sri Lankan continental margin also displays the requirements described in SOU therefore it submitted their claim based on the interpretation of SOU to avoid the inequality that would result if it go by Article 76(4). This paper will discuss the Sri Lankan claim to the Commission on the Limits of the Continental Shelf (CLCS) and the claims submitted by Kenya, Myanmar and Bangladesh.

The aims of the study are to identify the existing legal framework regarding the claim, to examine why the negotiations were slow moving and to provide recommendations to develop our claim. Authors use secondary sources such as library resources and internet inclusive of books, Journal Articles, Cases and other related statutes as main sources of this research.

The strengths and weaknesses of the claims made by the other countries to the CLCS are analysed for providing

recommendations to the study. The comparative study will assist in uncovering what is unseen of our claim.

**Keywords** - Continental shelf claim, Sri Lanka, Strengths, Weaknesses

## I. INTRODUCTION

The ocean floor differs from country to country therefore each country has to measure the continental shelf for themselves. Sri Lanka is an island which is situated in the Southern part of the Bay of Bengal. Bengal Bay deep sea fan effect leads to wash the Sri Lankan continental shelf whereas fan creates huge sediments and those sediments are identified as rich mineral resources.

These sediments and the Bengal Fan is a special geographical character and it needs to be addressed separately with regard to establishing the outer edge of the continental margin. Article 76 of the LOSC is silent on the issue of applying special rules to establish the outer edge of the continental margin to the states having special geographical and morphological characteristics such as Sri Lanka. In consequence fitting into Article 76 is inequitable to Sri Lanka because if the country go by Article 76 substantial part of the continental shelf would not fall within the provisions of that Article. Since the shelf contain large deposits of gas hydrates that contain methane, concentrations of Lead, Zinc, Gold, Silver and fisheries like sedentary species it will be a huge economic disadvantage losing that extended area of the shelf.

Nevertheless the SOU is different from Article 76 and it contains a specific method in establishing the outer edge

of the continental margin which recognise the inequity that would result to states with special geographical features. The Sri Lankan submission to CLCS in May 2009 is made in accordance with Paragraph 8 of the Article 76 of the LOSC and Article 3 of Annex 2 of the Convention. Since the SOU do not make any reference to the states which can make submissions to CLCS states like Kenya, Myanmar and Bangladesh have made their claims to extend their continental margin based on the SOU. Sri Lankan submission overlaps with India, Myanmar and Bangladesh to a greater extent. It is noted that Myanmar and Bangladesh have settled their dispute concerning delimitation of the maritime boundary in the Bay of Bengal, according to the judgment delivered on March 14, 2012 by the International Tribunal on the Law of the Sea. In the matter of the Bay of Bengal Maritime Boundary Arbitration between Bangladesh and the Republic of India, an award was made on July 2014 in favour of Bangladesh. Accordingly, the maritime disputes of the three main countries in the Bay of Bengal have now been settled and international oil companies are showing a keen interest to carry out exploration and production operations in these countries leaving Sri Lanka out with serious delays in settling our maritime boundary in the east under Annex 11 of the final Act of UNCLOS.

For this reason it is worth studying the reasons for the delay by analysing the strengths and weaknesses of the Sri Lankan claim with special reference to the claims of Kenya, Myanmar and Bangladesh. In this paper section II explains the legal framework relating to the Sri Lankan continental shelf claim and in section III Kenyan, Myanmar and Bangladesh claims are analysed. Section IV examines the strengths which support the Sri Lankan claim and the weaknesses that beat down the claim. Section V presents the recommendations and section VI provides the conclusion.

## II. THE LEGAL FRAMEWORK RELATING TO THE SRI LANKAN CONTINENTAL SHELF CLAIM

Sri Lanka is a state in the southern part of the Bay of Bengal. Sri Lanka signed the United Nations Convention on the Law of the Sea on 10th December 1982 and ratified it on 19th July 1994. On 8 May 2009, the Democratic Socialist Republic of Sri Lanka submitted to the CLCS, in accordance with Article 76, paragraph 8, of the United Nations Convention on the Law of the Sea, information

on the limits of the continental shelf beyond 200 nautical miles from the baselines from which the breadth of the territorial sea is measured. This submission relates to the delineation of the outer limit of the continental shelf of Sri Lanka by a specific method set forth in the SOU.

Sri Lanka's continental margin displays the special geological and morphological characteristics described in the SOU. The morphology of Sri Lanka's continental margin is characterised by a very narrow shelf, very steep slope and an extensive rise. Sri Lanka has established its outer limit of the continental shelf in accordance with the method specified in the SOU namely, by straight lines not exceeding 60 nautical miles in length connecting fixed points, defined by latitude at of which the thickness of sedimentary rock is not less than 1 kilometre. Sri Lanka requests the Commission to make its recommendations on matters related to the establishment of the outer limits of the continental shelf of Sri Lanka in accordance with the SOU and paragraph 1(a) of Article 3 of Annex II to the Convention.

Sri Lanka has no pending maritime boundary dispute with neighbouring states. Sri Lanka has not concluded any agreement on the delimitation of the continental shelf beyond 200 nautical miles from the baseline from which the breadth of the territorial sea is measured. The submission is made in accordance with Article 76(10) of the Convention, the recommendations of the Commission will be, without prejudice to the delimitation of maritime boundaries between states with opposite or adjacent coasts. Sri Lanka has held consultations with India concerning Sri Lanka's submission to the Commission. During these consultations, it was decided that both sides would file their respective submissions before the Commission without prejudice to any future bilateral agreement.

## III. CLAIMS MADE BY OTHER COUNTRIES

Countries like Kenya, Myanmar and Bangladesh have made their claims to the CLCS based on the special method identified in the SOU. The claims of these countries are analysed below.

### A. Continental Shelf Submission of Republic of Kenya

Kenya is a coastal state in East Africa. Kenya is a party to the Law of the Sea Convention which it signed on the day it was opened for signature on 10th December 1982

and later ratified it on 2nd March 1989. As provided for under the Article 76(1) of the Convention, Kenya has a continental shelf comprising the seabed and subsoil of the submarine areas that extends beyond its territorial sea throughout the natural prolongation of its land territory to the outer edge of the continental margin, up to the limits provided for in Article 76 of the Convention. The data submitted by Kenya in support of this Submission establish that the outer edge of the continental margin appurtenant to Kenya's land territory extends beyond 200 nautical miles measured from the territorial sea baseline. Seeing that reference to the states in the southern part of the Bay of Bengal in the 5th paragraph of the SOU does not preclude the application of the general principles where any other state is able to demonstrate the existence of geological and geomorphological characteristics similar to those exhibited by a continental margin of a state in the southern part of the Bay of Bengal. Application of the SOU cannot be limited to a geographical region is the basis of the Kenyan claim. For the purposes of establishing the outer edge of the continental margin, Kenya has applied the specific method contained in the SOU. In this regard, the Government of Kenya is firmly of the view that the application of the specific method set out in the SOU is consistent with the terms of the SOU having regard to the particular and special characteristics of the continental margin of Kenya and recognizing the inequity that would arise in the event that Kenya were to be required to apply the provisions of Article 76(4) under these circumstances. Therefore it is evident that Kenya invokes the specific method for the establishment of the outer edge of the continental margin set out in the SOU, together with Article 76(5) (6) (7) of the Convention in support of this Submission.

### **B. Continental Shelf Submission of Union of Myanmar**

Myanmar signed the Law of the Sea Convention when it opened for signature and ratified on 21 May 1996. It entered into force for Myanmar on 20 June 1996.

The submissions is made by Myanmar to the CLCS pursuant to Article 76(8) of the Convention in respect of the establishment of the outer limits of the continental shelf beyond 200 nautical miles from the baselines from which the breadth of the territorial sea of Myanmar is measured. Myanmar is making its submission for extension of its continental shelf in the Bay of Bengal, off Rakhine, and referred to as Rakhine Continental Shelf, beyond 200 nautical miles.

The outer limits of Rakhine Continental Shelf as herein

submitted to the Commission are based on the provisions of Article 76 and of Annex II of the Final Act of the Third United Nations Conference on the Law of the Sea.

The natural prolongation from land mass of Myanmar through the outer edge of the Rakhine continental margin has three aspects. They are morphologic, geologic and tectonic aspects. Morphologically, the land mass of Myanmar progressing westward can be described in terms of the shelf, the slope and the rise. Beyond the rise lies the deep ocean floor of the Bay of Bengal. Geologically, the Rakhine continental margin is the westward advancing accretionary complex of the Burma plate. Regarding both geological and tectonic aspects, the land territory of Myanmar embraces two major tectonic domains and the "Burma plate" is the western domain of the two. The Burma plate and the accretionary complex along its western margin are comprised dominantly of marine sedimentary rocks. The abyssal plain in the northern Bay of Bengal is underlain by the Bengal Submarine Fan System. As a consequence, the accretionary complex is built up with the sediment scraped off from the subducting Indian plate beneath the Burma plate. Utilising the provisions contained in paragraphs 4 to 10 of Article 76 it is demonstrated that Myanmar is entitled to extend its continental shelf limits beyond 200 nautical miles due to the morphological and geological as well as tectonic significance of the Rakhine continental margin. Therefore, both one per cent sediment thickness formula and provision of Annex II of UNCLOS are used to delineate the outer limit of the extended Rakhine continental shelf. This submission is not subject to any dispute between Myanmar and other States.

### **C. Continental Shelf Submission of People's Republic of Bangladesh**

Submission by the People's Republic of Bangladesh to the CLCS is made pursuant to paragraph 8 of Article 76 of the 1982 United Nations Convention on the Law of the Sea. Bangladesh is a Contracting Party to the Convention, having signed it on 10 December 1982 and later ratified it on 27 July 2001. As provided for under paragraph 1 of Article 76, Bangladesh has a continental shelf comprising the seabed and subsoil of the submarine areas that extend beyond its territorial sea throughout the natural prolongation of its land territory to the outer edge of the continental margin. This submission is made by Bangladesh in support of the establishment of the outer limits of the continental shelf where it extends beyond 200 nautical miles from the territorial sea baselines. India lodged a submission to the Commission on 11 May 2009. Bangladesh formally objected to the Indian submission.

With regard to Myanmar, Myanmar lodged a submission to the Commission on 16 December 2008. Bangladesh formally objected to the Myanmar submission. Bangladesh disputes the claim by Myanmar to areas of outer continental shelf noting that the areas claimed form part of the natural prolongation of Bangladesh.

A number of large river systems, including the Ganges, Jamuna, Meghna, Godavari, Mahanadi, Krishna and Kaveri all flow into the Bay of Bengal. The accumulation of sediments discharged by these river systems and their ancestors over millions of years, has resulted in the development within the Bay of Bengal of a prominent submarine feature known as the Bengal Fan. The geology of the region is special when comparing to other states. The accumulation of sediments discharged by river systems has resulted in the development within the Bay of Bengal of a prominent submarine feature is the base of the continental shelf submission of Bangladesh.

#### IV. RECOMMENDATIONS

It is to be noted that each of these claims overlaps and the countries should be equipped well in order to defend their respective claims. Recently Bangladesh objected to Sri Lankan continental shelf claim stating that Sri Lanka has claimed an outer continental shelf entitlement beyond the constraints line established by Article 76(5) of the Convention. According to the UN laws, a country can have the continental shelf rights up to 350 nm or 100 nm from the 2,500 metres depth, which one is higher. But Sri Lanka from its baseline claimed about 1,000 nautical miles, which is India and Bangladesh's continental shelf territory. Likewise there are disputes among states in the process of extending their outer limits of the continental margin. The importance of the negotiation process is highly important in respect of maintaining good diplomatic relationships among states.

There is a provision under clause 4 of Annex 1 of the Rules of Procedure of the Commission on the Limits of the Continental Shelf (CLCS) for joint submissions from adjacent coastal states by joint surveys and bilateral discussions. Sri Lanka should initiate such action with India in the continental boundary delimitation in the southern Bay of Bengal. An example of such bilateral and multilateral cooperation is indicated in the recent joint submissions made to CLCS by France, Ireland, Spain and the United Kingdom covering the Celtic Sea and the Bay of

Biscay. Also make a joint submission to the UNCLCS with India will pave the way for an early resolution of our dispute on the continental shelf boundary. Also to expedite the delimitation of our continental shelf boundary following these observations are strongly recommended. Firstly identify the negotiating team from Sri Lanka consisting of the representatives from the Foreign Ministry, Attorney General's Department, National Hydrographic Office and Oceanography Division of NARA. Then identify a senior consultant who had negotiated Annex 11 of the final Act of UNCLOS to lead the Sri Lanka team for bilateral negotiations. Then it leads to fasten the negotiations between the states regarding the delimitation of the outer limits of the continental shelf in Sri Lanka. This study has identified the importance of the expertise knowledge in the field of the Law of the Sea. Most of the individuals who has the responsibility towards the Sri Lankan claim are not experts in the area of Law of the Sea. As a result the quality of the negotiation process will be reduced because of the lack of the knowledge in the area and the technical points that the international community stress will not be taken into account since the lack of knowledge. It is to be highly noted that this claim is heard before the international tribunal therefore convince them will be our sole responsibility by adopting the measures which are suitable for our country as soon as possible.

#### V. CONCLUSION

Sri Lanka is a country situated in the southern part of the Bay of Bengal. Due to deep sea fan effect in the Bay of Bengal huge sediments have been created and Sri Lankan ocean floor reflected special geographic characteristics. Statement of Understanding is an exception to Article 76, allows for a specific method for Sri Lanka to be used for the purpose of measuring the continental shelf. It is based on equity. Exception permits Sri Lanka to avoid the consequences of the formula then proposed for defining the continental margin, which was based on the thickness of sediments. The consequences of accepting the above mentioned formula would have meant that Sri Lanka would have lost over 60 percent of the continental margin. This is entirely inequitable since the continental shelf is prosperous with rich mineral deposits and other resources, Sri Lanka will be losing an unbelievable amount of financial benefit.

The Sri Lankan continental shelf claim has its own ups and downs. Apart from the claim itself the local officials who are responsible for the implementation of the claim has been

slow in their way for make this claim a successes. The best example is that the other countries which have relied on the SOU have finished their claims and the outer limits of the continental shelf has been determined in those countries. But Sri Lanka is still in their way of achieving that dream. This study assist to identify the pros of the other claims based on their claims on SOU and those aspects will be taken in the process of providing recommendations to this study in order to develop the Sri Lankan claim and those recommendations will finally assist to improve the quality of the Sri Lankan claim and the procedure of negotiation with the CLCS. All of the study recommendations will pave their way towards achieving on big dream that is to witness the triumph of the Sri Lankan claim.

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# WRONGFUL CONVICTIONS AND REMEDIES TO MINIMIZE IMPRISONMENT

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**Abstract** - Wrongful conviction is generally viewed as the conviction of a factually innocent person. It denotes the exoneration of an individual who was convicted of a crime that he or she did not commit or have any stake in. In the present context, there are so many innocents convicted wrongfully in Sri Lanka and a large number of cases have been reported regarding wrongful conviction of innocents.

Wrongful accusations (e.g., by eyewitnesses, forensic scientists, or the police) include errors in the process of administration of justice that is supposed to correct errors and prevent wrongful convictions (e.g., errors by counsel or judges or errors resulting from deficiencies in the institutional framework for the conduct of trials or review of convictions). It is evidenced that large number of innocent persons are imprisoned due to wrongful convictions not even in Sri Lanka but in comparative jurisdictions as well.

Therefore, time has come to take necessary action to prevent such wrongful imprisonments and to produce real offenders to the court and to charge them accordingly for their criminal activities. Thus, this research study is focused on identifying the causes of wrongful convictions and making recommendation for mechanism to check the accuracy of the verdict or act and to catch the real offenders in criminal justice system.

The qualitative research method will be used for this study. Under the qualitative research method data will be collected through secondary sources. Secondary data will be collected from published books, journals, theses and online data from websites, e-databases, e-journals, e-theses and e-books. Collected data will be analyzed through its strengths, weaknesses, opportunities and

threats to prevent imprisonment of innocence. In this context, it will reveal the existing strengths to prevent the wrongful convictions as well as weaknesses. In one hand, it will discuss the opportunities the victims have to prove their innocence.

On the other hand, it discusses existing threats for victim, if their innocence is proved. In this research study, it is expected to find out a concrete solution to wrongful convictions and to educate public on how to escape from such convictions and to justify the criminal justice system.

**Keywords** - Wrongful conviction, Imprisonment of innocence, Criminal justice system

## I. INTRODUCTION

A wrongful conviction is defined as the criminal conviction of an actually innocent person. Actual innocence does not mean innocence based on a defect in the legal proceedings. It means factual innocence. A wrongful conviction is the conviction of someone who had no involvement in the crime charged whatsoever (Deskovic, 2012). Similarly, Roman, Walsh, Lachman and Yahner, (2012) stated that conviction may be classified as wrongful for one of two reasons (1) the person convicted is factually innocent of the charges, or (2) there were procedural errors that violated the convicted person's rights. Roman et al further pointed out that DNA evidence is the tool used to detect wrongful convictions.

Post-conviction DNA testing cannot be used to detect erroneous convictions due to reversible procedural errors. Moreover, they stated that previous research on wrongful convictions has been based on data known only for cases in which the convicted offender (or others on his/her



behalf) actively pursued exoneration. Given this caveat, there is a substantial body of literature that indicates certain attributes of the victim, offender, and crime may be associated with the likelihood that an individual is wrongly convicted.

## II. PROBLEM STATEMENT

The discovery of innocence also has propelled criminal justice reforms aimed at reducing the likelihood of future wrongful convictions. Policy reforms regarding eyewitness identification, false and coerced confessions, evidence preservation, and forensic oversight are aimed at curbing wrongful convictions. While reforms in these areas are ongoing and uneven, concerns about convicting innocent people have inspired reforms within the criminal justice system (Baumgartner, Westervelt, Cook, 2013). Thus, this research study is focused to identify the causes of wrongful convictions and to find out a method to check the accuracy of the verdict or act and to catch the real offenders in criminal justice system to minimize the imprisonment of innocence.

## III. LITERATURE REVIEW

False eyewitness testimony and faulty forensic evidence were the leading causes of wrongful convictions (Conners et al. 1996; Garrett 2008, Gross et al. 2005; Innocence Project web site). In the Garrett (2008) study, false eyewitness testimony contributed to a wrongful conviction in 79 percent of his sample, while faulty forensic evidence was present in 55 percent of wrongful convictions (a defendant could be convicted based on more than one type of evidence, so these percentages do not sum to 100 percent).

Wrongful convictions have had devastating effects on the lives of the convicted and their families. Imprisoned for years, these innocent individuals frequently lose their jobs, their homes, their reputations and sometimes those that matter most to them - their spouses and partners, friends, children and other family members.

They are released from prison after years or decades, often just with the shirts on their back (Aborn, n.d.). Aborn further stated that the conviction of an innocent individual - while the actual offender goes free - erodes both public safety and confidence in the criminal justice system. Scientific advancements have led to the increased use of forensic evidence, particularly DNA, to exonerate

wrongfully convicted individuals. But law enforcement has not always kept up with the advances of science. However, it is evidenced that identifying the causes of wrongful convictions and implementing practical reforms that can be increased the fairness, accuracy and reliability of criminal justice system. According to the existing literature it is proved that there are many other wrongful convictions that have been cleared without the benefit of DNA. Misidentification can be occurred in either photo or live line ups.

Apart from that, other factors can be taken as false forensic testimony, reliance on unreliable or limited forensic methodologies such as microscopic hair comparison or serology inclusion), testimony from informants or accomplices with incentives to lie, false confessions and guilty pleas, suppression of exculpatory evidence, ineffective assistance of counsel, and investigative and prosecutorial tunnel vision (The Justice Project, 2009). It further revealed that the most fundamental and important protection against wrongful conviction is access to a qualified defense attorney.

With appropriate investigative and expert resources, defenders can meaningfully test the evidence against their clients and argue an effective line of defense. In practice, defenders frequently go without these much-needed resources and may often lack training, skills, and support—all factors that put innocent defendants. In this context, it is clear that there should be a qualified lawyer who has gained experience and skills to handle such cases without putting the innocents in trouble. Moreover, The Justice Project further stated that the crimes that are committed in the time between a wrongful conviction and the identification of the true culprit are an immeasurable cost to the community.

Not only that, true culprits are not investigated or punished and due to that public safety is at risk. In one hand, it takes long time to clear the wrongful convictions and to imprison the real culprit. On the other hand, most of the wrongful conviction cases are dried up un-resolving.

## IV. METHODOLOGY

The qualitative research method was used for this study. Denzin and Lincoln (1994) defined that qualitative research as “multi-method in focus, involving an interpretive, naturalistic approach to its subject matter. Under the qualitative research method data was collected

through secondary sources such as published books, journals, theses and online data from websites, e-databases, e-journals, e-theses and e-books.

**A. Data Analysis**

Collected data was analyzed through SWOT analysis system and in this manner it is discussed the strengths, weaknesses, opportunities and threats of suggested remedies for wrongful convictions.

**V. RESULTS AND DISCUSSION**

**A. Causes of Wrongful Convictions (Deskovic, 2012)**

1. Victim misidentification
2. Eyewitness misidentification

**B. Reforms to Reduce Misidentification**

1. Sequential Lineups and Photo Arrays
2. Lineup Choices or Photographs that are Similar in Appearance
3. Informing Victims and Witnesses the Perpetrator May Not Be Present
4. Advising Victims and Witnesses the Investigation Will Continue Whether or Not They Make an Identification
5. Utilizing the Double-Blind Method
6. Video recording the identification process
7. Allowing confidential statements by witnesses regarding their level of certainty about the identification; and, finally
8. Eliminating show-ups.

**In this context, collected data can be analyzed as follows.**

- 1) Strengths: As suggested by Deskovic (2012) the above-mentioned reforms can be applied to reduce misidentification.
- 2) Weaknesses: Causes of wrongful convictions can be treated as weaknesses.
- 3) Opportunities: Scientific advancements have led to the increased use of forensic evidence, particularly DNA, to exonerate wrongfully convicted individuals can be taken as an opportunity to minimize the imprisonment of innocence at some extent.

- 4) Threats: False eyewitness testimony and faulty forensic evidence were the leading causes of wrongful convictions can be considered as one of the major threats to identifying the culprit.

It is suggested to evaluate the proposed reforms by lawyers, judges, legal scholars, criminologists to obtain the accurate, reliable confession to prevent wrongful convictions.

**V. CONCLUSION**

It is far better to prevent wrongful convictions in the first place than to remedy them after the fact. Thus, the cases built upon confessions require careful evaluation of the suspect, police tactics, verifying evidence, and recordings of the questioning.

Prosecutors can reject cases built upon coerced confessions and insist police investigators amass additional reliable evidence to support the charges. Prosecutors should review cases based on identification with care, and search for significant signs of misidentification, such as a victim's description of a perpetrator is not fitting with the suspect's physical characteristics, lineups and photo arrays were presented in a suggestive manner; etc. Moreover, it is proved that systemic deficiencies lead to wrongful convictions, and be on the lookout for false confessions, misidentification, incentivized witnessing, bad lawyering, junk science, prosecutorial misconduct, and prejudicial pre-trial publicity (Deskovic, 2012).

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# CURSE OF FLYING DEATH AND DILEMMA OF LAW: CHALLENGES OF INTERNATIONAL HUMANITARIAN LAW BEFORE DRONE ATTACKS

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**Abstract** - Usage of new technology in warfare has bamboozled the existing customs and etiquettes in battlefield. Especially the innovation of Drone as a lethal weapon in the battle field has created much complexities in International Humanitarian Law.

The greater problem of Drones is that it unlike other weapons or mass destructive methods, entirely Drones do not possess the military features. With regard to the current legal implications Drones have not been regarded as a prohibited weapon by any international treaty or customary law. Neither Drone have been prohibited by the Article 8 of Rome statute as they do not exhibit any banned qualities such as causing indiscriminate harms or unnecessary sufferings. In fact Article 36 of Additional Protocol 1 of Geneva Convention states a new weapon could be acquired, if it is not prohibited by the protocol. This legal ambiguity has created a heavy loophole in the black letter law to legitimize this deadly weapon.

As a matter of fact number of issues regarding the nature of belligerents, whether Drone has ability to distinguish a military target from civilian arise and this paper's main objective is to trace those legal lacunas in International Humanitarian Law regarding the usage of Drones in war. Methodology of the research will be based on a doctrinal approach and Geneva conventions, ICRC document, 1 additional protocol shall be used as the primary document along with other available literature.

The remedy that can be taken within International Humanitarian Law against Drones will be further discussed in this paper and it will enlighten the reader about the present challenge in IHL on Drones and the routine that has created this problem.

**Key Words** - Drones, Belligerents, Civilians, International Humanitarian Law

The use of deadly weapons to annihilate the enemy in the battlefield has been existing since the time of immemorial and such weaponry made severe impacts on world community over regulating restrictions to sustain harmony on earth. The whole notion of International Humanitarian law is based on rules and regulations of warfare. But it is a fact beyond dispute that changing technologies, naval innovations of 21st century have demonized the conventional nature of warfare and which has created many dilemmas to International Humanitarian Law. Undoubtedly the influx of Drones in warfare has aroused new questions for us. In the long evolution of Drone aircrafts which dates back to 19th Century U.S Civil War era, the real idea of using Drones in warfare as a lethal weapon was conceived in the U.S during post Vietnamese war period, Especially after 9/11 incident Drone attacks became one of the main methods used by the U.S force in Afghanistan to target Al-Qaida carders. According to the recent reports of the Bureau of Investigative journalism, up to 3,900 people have been killed in 422 Drones strikes, where the Drones are controlled by the Central

<sup>1</sup> Milson RO, Killings by Drones: Legality under International Law, The Foundation for Law, Justice and Society, 2013, P 76

<sup>2</sup> I.C.J Reports 1996, p 226

Intelligence Agency (CIA)<sup>1</sup>. The situation has been worst in regions like Yemen and Syria since most of the Drone attacks killings have not exposed to the outside world from these territories.

It is important to look at the legal implications laid down by International Humanitarian Law in such a context. Regarding the laws on Drones attacks, law has left a tremendous ambiguity and it is worthy to point out that all Drones are actually armed and used to fight. There are many instances that Drones have used for non military targets like gathering information etc. With regard to the current law that Drones are not a weapon perform that is not specifically prohibited by any international treaty or by customary law, neither Drones have been prohibited by the Article 8 of Rome Statute as they do not exhibit banned qualities such as causing indiscriminate harm or unnecessary sufferings. According to Article 36 of the Additional Protocol 1 of the Geneva Convention, a new weapon could be acquired if at all it is not prohibited by the protocol. Ostensibly this legal loophole increases the understanding of Drones as a weapon which the usage will amount to a war crime.

As a matter of fact there are various pure technical types of legal issues spring the use of Drones in warfare. Are Drones aircraft operators' unprivileged belligerents? Article 43 of Additional Protocol 1 has stated "Wearing Uniform or carrying of Arms openly" as one of essential conditions for combatants, in that sense a CIA operative who controls a Drone Aircraft from Swat Valley or Kabul will not be fallen under combatant category. Secondly Usage of Drones has created practical difficulties with the "distinctions". Additional Protocol 1 of the 1977 states that in order to ensure respect for and protection of the civilian population and civilian objects, the parties to the conflict shall at all times distinguish between the civil population and combatants and between civilian objects and military objectives also accordingly shall direct their operations only against military objectives. Even in the International Court of Justice, the Court had discussed these safeguards regarding humanitarian principles in Nuclear Weapons Advisory Opinion<sup>2</sup>. In the respective opinion Court cited the principle of distinction as a cardinal rule of International Humanitarian Law. The usage of Drones has caused superfluous injury as well as indiscriminate attack by slaughtering many civilians who were not a part of the conflict. In many of the military operations parties

had relied on Drones as a best option for targeted killings. In an instances at Pakistan, a Drone targeted to kill 41 terrorists but tragically ended with a toll of 1, 1142.

One of the biggest issues on Drones is whether it has potentiality to distinguish a military target from a civilian object. U.S defense analysts have heavily verified the military technology Drones and they claim Drone would be an ideal equipment to reach the military target without making any civilian casualties because Drones are highly technical and systematic than conventional war equipments. But ironically recent history of Drones attacks has shown how Drone target killings have become fatal upon civilians rather than chasing its intended targets. Common logic of U.S on this ponderable situation is terrorists always mingle with civilians as a method to avoid Drones and it leads to increase the heavy casualties on civilians. But a question arises how a responsible state like the U.S can bring such an irrational defence against a non state actor which leads to a pathetic destruction of human lives and properties. While giving an interview to the British Institute of International and Comparative Law, Kord Bingley made a clear remark on Drones<sup>3</sup>. His Lordship states,

"From time to time in the annals of history of international law, various weapons have been thought to be so cruel as to be beyond the pale of human tolerance. I think, cluster bombs and land mines are the most recent examples. It may be, I am not expressing a view, that unmanned Drones that fall on a house full of civilians is a weapon that international community should decide not to be used"

On the other hand a lack of legal clarifications for Drone is another issue which impedes law to make further actions. According to the "Manuel on International Law applicable to air and missile warfare" prepared by Harvard programme on Humanitarian policy conflict research "A weapon is a means of warfare that is capable of causing injury or death of persons or the damage or destruction of objects. But Drones do not fall under this category because Drone is a mere flying object and it is not the Drone that has to be reviewed in the light of the prohibition, but any weapons it carries. Most of the time Drones which are used for mandatory operations possess high technological equipments to distinguish its targets, moreover the Drone operator has to assess the situation around the target to ensure that the attack is conducted

<sup>3</sup> Lewis MW, Targeting operations with Drone Technology, American Society of International Law, 2013, p 46

discriminately. However from the legal perspective the development of such new technologies is also governed by treaty law. As an example Article 36 of Additional Protocol 1 clearly emphasizes states must determine whether the employment of new means of warfare would in some of all circumstance, be prohibited.

When it comes to targeted killings issue, Drones have its ruthlessness as a deadliest object which chases its target till the last ditch. Not only that in International Humanitarian Law even under Human Rights Law targeted killings are likely never to be lawful. Article 6 of ICCPR could be taken as a main legal justification for this assessment. It prohibits the use of lethal force without any legal reasons. It is evident factor most of the time U.S and Israeli military forces have used Drones to assassinate their targets and also some of those targeted persons are not direct combatants who directly take part in hostilities. For an instance more than 50% of Drone operations had targeted either Al Quida operatives or suspects in Afghanistan and Pakistan. But their targets have ultimately brought heavy casualties to civilians. One of cases has reported from West Bank in Israel where Israeli Drone had targeted a Hamas leader and it killed his two children and pregnant wife along with the Hamas leader<sup>4</sup>.

However U.S state department has declared that basic objective of using Drones is make an effective success in the war against terrorists like ISIS, in that case they do not represent a regular armed force and there for not considered to be combatants. If International Humanitarian Law applies in those cases, the crucial question, regardless whether targeted persons is a "Fighter" in a non international armed conflict, or a civilian in any form of conflict, is whether each targeted person was directly participating in the hostilities. But requirement for direct participation in hostilities are not verified by Geneva Conventions or Additional Protocols. This became a grave issue when Israeli official policy of targeted killings by using Drones was questioned before Israeli Supreme Court in 2006. Israel was not a party to Additional Protocol 1, so that Israeli Supreme Court adhered to functional approach. Under that approach Court evaluated the direct participation of civilians by examining whether those Drones targeting involved in civilian activities or combatant activities.

The most critical justification which has been applied by the parties in favour of Drone attacks is that using Drones and targeted killing is a part of self defence. Especially U.S administration attempts to white wash Drone attacks with right of self-defence. U.S view on the justification of Drones has further stated the U.S is in armed conflict with global terrorism this legal justification is a position of devil and the deep blue sea. It is disputable whether, and in which areas of Afghanistan and Pakistan, international or non international armed conflict exists. However in order to fight against the terrorism, it seems that the scope of using Drones has already reached beyond the limits of conflict zones. As an example once U.S citizen and his son was killed in Yemen by predator Drone attack and victims were initially labeled as Al Quida fighters but later found they were innocent. A legitimate question is these targeted killings fall under so called "Self Defence", however Drones strikes occurring outside these states territories cannot be seen as a part of self defence or a noble act against terrorism.

## CONCLUDING REMARKS

Legal Adviser to ICRC Jelena Pejic states "The ambiguity on the term's definition is not a question "especially" raised by the Drones but a general one, with such a complexity it is not the Drone that raises legal issues, it is the way Drones strikes can conducted" Lacuna of identifying Drones under IHL treaties could not be considered a mere simple factor<sup>5</sup>. Especially the International Humanitarian Law regulations should be strengthen o limit Drone attacks on civilians and which must be on the basis of traditional IHL concepts like distinction and proportionality. It is a fact that Drones are included high technical equipment to distinguish its targets but war crimes could result if these capabilities are misused Article 8 (2) A and (8) 2 B of Rome statute can be brought on Drone attacks under wilful killings. In general point of view the usage of Drones attacks becomes a breach of territorial sovereignty of a state under Article 2 (4) of UN Charter. The recent activities done by the U.S in Afghanistan and Pakistan boarder simply stands for that logic.

sThere is another less concerned area on Drones which has to be addressed. It is that the psychological impacts left by Drone Attacks in conflict zones. In reality people have been shuddered by Drone Phobia and that trepidation has

<sup>4</sup> "Jewish Blood revenge", Daily Express, 12th September 2014

<sup>5</sup> Pejic Jelena, Extraterritorial targeting by means of armed Drones; Some legal implications, International Review of Red Cross

left a strong psychological trauma among the people in those affected areas. Unlike other human involved warfare Drone is an automatic killing machine and such a machine cannot hear any ones plea.

Who will be liable to Drone strikes on civilians? This question has become the moot point of issue relating to Drones under International Humanitarian Law. Technically Drones are machines and they are controlled by the operatives who are not lively involved in the battle field.

Indeed Drones operations function from far away from the real battlefield and such a scenario has made difficult logic to bring remedies under International Humanitarian Law. But this should not be a defence since Drones operations are thus no different than the pilots of aircrafts such as helicopters and those operators should be obliged to comply with international humanitarian law principles, which includes the principles of distinction and proportionality.

The territorial scope of armed conflict is another complex issue envisaged by International Humanitarian Law in respect of imposing legal mechanism over armed Drones. The individual specific references to "Territory" included in Geneva conventions and their additional protocols have thus recently given rise to difference on what has been termed the legal geography of war. Especially this situation occurs in a context of a non-belligerent state.

However these given factors have muddled up the normal understanding of International Humanitarian Law on means and methods of warfare, nevertheless strong legal implication on usage of Drones in armed conflict is mainly needed to prevent so many havocs. Above all greatest danger is the result of using Drones would be unimaginable if that technology meets the hands the non-state actors like terrorist groups. As the old adage goes "What good for the goose is good for the gander". In that sense thus far Drones have used by states but the risk and danger would be doubled if non state parties get the control over this fatal equipment.



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# A STUDY ON STRENGTHENING THE LAWS ON GENETICALLY MODIFIED ORGANISMS IN SRI LANKA WITH SPECIAL REFERENCE TO THE PROPOSED REGULATORY MECHANISM

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**Abstract** - The agricultural and fisheries industries have traditionally been supportive of technological innovation, particularly in the field of genetic improvement. For decades, these industries have been mixing naturally the genetic traits of seeds and animals in the search of varieties that are able to express a desired trait. Genetically Modified Organisms (GMO) is a noteworthy step forward in the production of agricultural crops. Although this method is more efficient, a number of scientific evidence manifest the fact that “novel gene combination” may have health and environmental impacts that are not being adequately addressed at present.

Thus a proper legal framework should be established to ensure that the quality of the imported and domestically produced GMOs are harmless to the human health and bio diversity of Sri Lanka. Despite the significance of this requirement, proposals for precise legislation are still in discussion stages. Hence, the main objective of this research is to evaluate whether the existing legal framework can be effectively utilised to ensure that the biodiversity and human health of Sri Lanka are not negatively affected by the importation and domestic synthesis of GM seeds and other products.

The secondary objectives are to analyse the impact of GMOs to various facets of a country, to analyse the steps taken in the international arena to combat the above mentioned issues, to examine the factors that may be prompting the delay of the enforcement of the said law and to give recommendations to the domestic legal framework in light of international standards. This research is

carried in the form of a library based research and a qualitative research design is adopted. Case laws, statutes, conventions are used as primary sources whereas books, journal articles, conference papers, research papers, internet-web related information, newspaper articles and other legal instruments and resolutions of international/regional institutions are used as secondary sources. The key findings of this research show that the existing laws can be utilized to a considerable extent in fortification of bio diversity and human health in Sri Lanka. Furthermore, this study seeks to propose several additions in light of the precautionary principle to achieve the ends that cannot be accomplished by utilizing existing domestic laws alone.

**Keywords** -Bio-safety policy, Genetically Modified Organisms (GMO), Living Modified Organisms (LMO), Biotechnology, Human Health

## I. INTRODUCTION

“When it comes to owning the seed for collecting royalties, the GMO companies say, ‘it’s mine’. But when it comes to contamination, cross-pollination, health problems, the response is ‘we’re not liable.’”

-Vandana Shiva

In the modern world, technological development has been enhanced unprecedentedly. Genetic Modification of plants and other living organisms is one of such developments which has largely buttressed the agricultural arena in producing crops with a number of beneficial features. High yield, higher growth rate, high resistance to



pesticides and high resistance to weather conditions are a few of such features. However, scientific evidence have manifested serious adverse effects to the bio diversity and human health due to farming and consumption of GM products (Bakshi, 2003).

Under normal circumstances, a plant or animal can only acquire genetic material from other plants or animals of the same or closely related species. This mechanism does not allow the existence of life forms that are not suitable for the natural conditions (Environmental Foundations Limited, 2001). Application of biotechnology allows selected individual genes to be transferred from one organism into another, also between non-related species. It is therefore one of the methods to introduce novel traits or characteristics into micro-organisms, plants and animals (Plan & Eede, 2010). One such example is the insertion of anti-freezing proteins of fish species into strawberry plants to induce freeze-resistance traits in strawberries (Khammuang, et al., 2005).

Cartagena Protocol on Biosafety of 2000 defines 'Modern Biotechnology' as the application of:

a. In vitro nucleic acid techniques, including recombinant deoxyribonucleic acid (DNA) and direct injection of nucleic acid into cells or organelles, or

b. Fusion of cells beyond the taxonomic family, that overcome natural physiological reproductive or recombination barriers and that are not techniques used in traditional breeding and selection; the same Protocol defines Living Modified Organisms as 'any living organism that possesses a novel combination of genetic material obtained through the use of modern biotechnology' (Cartagena Protocol on Biosafety, 2000). The Secretariat of the Convention on Biological Diversity states that LMOs are usually considered to be the same as GMOs (Genetically Modified Organisms) in general usage (CBD Secretariat, 2013).

The ability of GM crops to produce higher and more reliable yield at a cheaper cost than their non-GM counterparts is believed to aid in reducing domestic and international hunger (Angelo, et al., 2013). Americans and Europeans are fortunate in that they have not experienced wide scale hunger in decades. Yet, the improved production and the process of globalization has not marked an end to the scarcity of food provisions in certain developing countries thus rendering the citizens of developing countries the main consumers of GM products (Blaustein, 2008). However, not only of low income countries, but also of high income countries many consumers are unaware of the GM substances that they consume (Tassel, 2009).

According to scientific research, negative effects of cultivation and use of GMOs include allergies, bio pollution, etc. The concept of biosafety refers to the need to protect human health and the environment from the possible adverse effects of the products of modern biotechnology. It describes efforts to reduce and eliminate the potential risks resulting from modern biotechnology and its products. In the present circumstances an urgent need to establish biosafety measures for Sri Lanka can be observed.

Regulations made under Section 32 of the Food Act No. 26 of 1980; Food (Control of Import, Labelling and Sale of Genetically Modified Foods) Regulations 2006 has set out regulations to be followed in the importation of GMOs to Sri Lanka. Apart from these regulations the only Act which Makes reference to the terms "genetically modified" (GM) and "living modified" (LM) is the Plant Protection Act.

Other legislation such as Fisheries and Aquatic Resources Act. No 2 of 1996, Water Hyacinth Ordinance Act No, 9 of 1909, Consumer Affairs Authority Act No. 9 of 2003, Animal Disease Act No. 59 of 1986, Fauna and Flora Protection Ordinance No. 2 of 1937 can be interpreted to a certain extent in the protection of human health and bio diversity in this regard. However, all adverse effects of modern bio technological activities are not directly addressed by these laws. The proposal made considering this position, by a Special Committee which included representatives from all relevant ministries is still in its discussion stages (Ministry of Environment and Natural Resources Colombo, 2005).

Although there remains considerable uncertainty about potential risks associated with modern biotechnology, the possible costs of mitigating or reversing any harm that may occur as a result of the use of modern biotechnology may also prove to be immense, and far-reaching, especially to the government who are ultimately responsible for assuring the health status and food security of the Sri Lankan population (Ministry of Environment and Natural Resources Colombo, 2005).

In this paper, Section II explains the potential threats to Human Life as well as the Bio Diversity of Sri Lanka due to the domestic synthesis, importation and consumption of GMOs in Sri Lanka. Section III analyses the existing legal framework that can be utilised to prevent environmental and health hazards caused by GMOs. Part IV examines the delay of the enforcement of the biosafety laws in Sri Lanka and Section V provides the conclusion and recommendations to the domestic legal framework in light of the examined international standards

## II. POTENTIAL THREATS TO HUMAN LIFE AND BIO-DIVERSITY DUE TO GMOS

### A. Threats to Human Life

“If you think organic food is expensive, have you priced cancer lately?”

- Joel Salatin

A number of laboratory studies have confirmed that some GM products could cause various negative effects such as extremely toxic contaminants and unknown allergens to human health. (Bakshi, 2003). One such example the Canadian research which successfully identified the presence of pesticides associated with GM foods in maternal, fatal and non-pregnant women's blood (Arisa & Leblanc, 2011). Another study conducted in France using mice revealed that the consumption of GMO maize treated with roundup herbicide (a product of the American agrochemical corporation Monsanto) caused tumours and multiple organ damage, including severe liver and kidney damage (Séralini, et al., 2012).

### B. Threats to Bio Diversity

#### 1) Fisheries and Aquatic Resources

The introduction of GMOs into Sri Lanka may not be limited to Genetically Modified Foods and crops. The techniques of genetic engineering had been used by scientists to make a number of new fishes so that they are able to express a desired trait thus being beneficial in the fisheries industry. Larger size and other desired traits would cause the GM fish to have better performance over their non-GM counterparts. Consumption of larger-sized prey, resistance to various environmental conditions are a few of such features that would cause greater competition that might result in the extinction of the non-GM species (Kapusinski & Hallerman, 1990). Some scientists argue that GM fish species can be created to be sterile, greatly reducing environmental risks that would result from interbreeding in the wild (Fletcher et al., 2001). Achieving 100% sterility, however, is next to impossible. (Logar & Pollock, 2005). Furthermore, the development of transgenic fish species is in its relative infancy and the science examining their potential effects on the natural environment is still emerging. In such circumstances, letting the citizenry and the ecosystem fall into risk is not a prudent decision a State can make.

An attempt by the Ministry of Fisheries and Aquatic Resources to introduce a Tilapia modified by human genes into mountainous streams of Sri Lanka in the year 2000 failed due to protests of environmentalists. These protests were based on scientific research indicating the potential dangerous effects on other species living in the same habitats and the consumers of the fish. Being a voracious and invasive species by nature, genetic modification can aggravate their ability to take over habitats thus creating an imbalance in the ecosystem. (Environmental Foundation Ltd, 2001).

#### 2) Bio

Sri Lanka's unique biodiversity has a very high global significance. It has been classified by Conservation Pollution Sri Lanka possesses a very rich wealth of biological diversity, reportedly the richest per unit area of land in the Asian region International (CI) as one of the “biodiversity hot spots” together with the Western Ghats in India based on the number of endemic plants and vertebrates. Therefore, it should be of utmost concern of the government and citizens equally to protect the country's bio diversity.

In Diamond V. Chakrabarty (1980), the United States Supreme Court approved the first patent application exclusively for a living organism. The patented microbe, however, was never developed beyond laboratory use in part because of the ecological uncertainties associated with releasing large quantities of Genetically Engineered Microorganisms into the environment. Ecological concerns over the release of Herbicide Resistant Crops are twofold. One concern is that the transgenic crops might invade natural habitats if their germination, root growth, resistance to abiotic stresses or dispersal has been enhanced. Secondly, genes transplanted to the crop for herbicide tolerance might transfer to other plants, thereby spreading herbicide tolerance in ways that are ecologically undesirable. Thirdly, successes of Herbicide Resistance Crops can result in the increased use of herbicides and/or compromise efforts towards incorporating integrated pest management. Fourthly, by building herbicide resistance into a few widely used low toxicity herbicides, the rate of weed resistance is likely to increase requiring the use of more toxic herbicides (Whitman, 2000).

#### 3) Super Weeds

Another concern is that crop plants engineered for herbicide tolerance and weeds will cross-breed, resulting in the transfer of the herbicide resistance genes from the crops into the weeds. These “super weeds” would then be herbicide tolerant as well. Other introduced genes may

cross over into non-GM crops planted next to GM crops (Whitman, 2000).

## II. EXISTING LEGAL FRAMEWORK ON GMO'S IN SRI LANKA

A National Bio Safety framework was prepared in April 2005. The overall objective of this framework is 'to ensure that the risks likely to be caused by modern biotechnology and its products will be minimized and biodiversity, human health and environment will be protected in a maximum way, regulating the transboundary movements through formulation of relevant policies regulations, technical guidelines and establishment of management bodies and supervisory mechanisms'.

The draft of the Biosafety Act of Sri Lanka is being reviewed at Legal Draftsman's Department at present. Until the said Act comes into force, several legislations already existing in Sri Lanka are utilized to be interpreted in preventing the hazards occurring from the use and planting of GMOs.

The draft Act stipulates that release of LMOs or GMOs should be undertaken in a manner that prevents or reduces risks to biological diversity and human health. It requires any exporter to notify the National Competent Authority in writing prior to the transboundary movement of LMOs/GMOs. It is a legal requirement to provide complete and accurate information of all required particulars in the application. The National Competent Authority, if it is deemed necessary, requires Sectoral Competent Authorities to carry out risk assessment on a case by case basis. The current position on GMOs is governed under several national legislations and international treaties. Fauna and Flora Protection Ordinance No. 2 of 1937 in its section 37 and 38(b) allows GM animals only for research purposes.

Section 21 of the Animal Disease Act No. 59 of 1986 prohibits the import of animals, animal products, veterinary drugs or veterinary biological products, animal semen or embryo except under the authority of a permit issued by the Controller of Imports and Exports on the recommendation of the Director of Animal Production and Health. Furthermore, Section 17 prohibits The manufacture of any veterinary drug or veterinary biological product in Sri Lanka except under the authority of a licence issued on that behalf by the Director of

Animal Production and Health. Effective interpretation of this Section can be used to prevent the import and domestic creation of Genetically Modified versions of the above mentioned components. Currently, discussions are being held pertaining to the development of Part V Animals Act No.29 of 1958 P, which deals with providing measures for the improvement of the breed of animals, to accommodate control of introducing breeding materials, including GMOs and LMOs, and the need to provide statutory status to the "National Animal Breeding Policy Committee" (Environmental Foundation Ltd, 2001).

Plant Protection Act No. 35 of 1999 prevents the introduction of any organism harmful or injurious to plants or destructive to plants in Sri Lanka. When considering Section 15, the provisions of Plant Protection Act can be used not only to prevent the entry of plants and animals, but also to prevent the import of any GM plasmid that could be potentially harmful to plants.

Consumer Affairs Authority Act No. 9 of 2003 in its Section 10(1)(a) issues general directions to manufacturers or traders to label the goods in respect of price marking, packaging, sale or manufacture of the goods. Since all genetic modifications relate to the manufacture of a good, this Section can be used to label all goods containing GMOs.

The Food Act No. 26 of 1980 amended by Act No. 20 of 1991 in its Section 2 prohibits the manufacture, import, sale or distribution of any food that, inter alia, is unfit for human consumption, is adulterated or is in contravention of the provisions of this Act or any regulation made there under. It is unlikely that the first section could be used any time soon because there is yet no concrete scientific information to prove that such food is unfit for human consumption. However, GMFs could be banned under Sec.2 (d), which refers to adulterated food. "Adulterated" is defined as "the addition of a substance as an ingredient in the preparation for food or subtraction of any constituent from such food or subtraction of such food to any other process or any other treatment so as to- render the food injurious to health, or affect its character, value, composition, merit or safety.

Under the third section, the Department of Health has already promulgated regulations to restrict and in some cases ban the entry of GMFs. The Food Act also has provisions relating to the labelling of foods. Section 3(1) says that "no person shall label, package, treat, process, sell or advertise any food in a manner that is false, misleading,

deceptive or likely to create an erroneous impression, regarding its character, value, quality, composition, merit or safety. Water Hyacinth Ordinance Act No, 9 of 1909 provide effective means to prevent the entry into or keep in one's possession and GM plants or parts that can be named in a gazette regulation.

Section 30 of the Fisheries and Aquatic Resources Act. No 2 of 1996 empowers the Minister to make regulations in consultation with Minister or Trade, having regard of the need to protect the aquatic resources of Sri Lanka, to prohibit or regulate the export from or import into, Sri Lanka of any species of fish including live fish or any eggs, roe or spawn or any products prepared thereof for a period of time. This Section can be interpreted to mean the power to prohibit importation of GM fish species that might have a negative effect on the human health and bio diversity. Furthermore, Section 35 empowers the Director of Fisheries and Aquatic Resources to permit local fishing boats to be used for research operations, experimental fishing or scientific investigations relating to fish and aquatic resources in Sri Lankan waters. He is further empowered to attach conditions as he may think fit regarding the conduct of such research operations, experimental fishing or scientific investigations. This Section can be interpreted to prevent scientific research focused on creation of harmful GM species in Sri Lanka.

In view of the above Statutory Provisions, it is evident that they can be interpreted to minimise potential harmful effects to a certain extent. However, the absence of a statute which plainly addresses the Biosafety issues can leave a loophole through which an astute importer or creator of GMOs can make his way to cause danger to human health and bio diversity of Sri Lanka solely for personal economic gains.

### III. INTERNATIONAL MECHANISMS RELEVANT TO SRI LANKA PERTAINING TO GMOS

Cartagena Protocol on Biosafety recognizes the importance of establishing credible and effective safeguards for LMOs to maximize the benefits of modern biotechnology while minimizing its potential risks. Sri Lanka signed this Protocol in 2000 and entered into force in 2004. The National Bio Safety Framework of Sri Lanka is a result of this ratification.

The Cartagena Protocol is an addition to the Convention on Biological Diversity. As a protocol, it is more detailed and more importantly, more binding. The Protocol's main aim is to regulate the trans-boundary movement of living modified organisms. Article 2 of the protocol states that it seeks to contribute to ensuring an adequate level of protection in the field of the safe transfer, handling and use of living modified organisms resulting from modern biotechnology that may have adverse effects on the conservation and sustainable use of biological diversity, taking also into account risks to human health, and specifically focusing on transboundary movements (Article 2).

Furthermore, Principle 15 of the Rio Declaration state "In order to protect the environment, a precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation." With this view, the Protocol embodies two important principles: the precautionary principle and the advanced informed agreement principle. The precautionary principle says that a State can take certain precautionary measures without having to back these up with scientific evidence. At first glance, it appears that this principle confers a privilege on technically disadvantaged countries. However, the Protocol goes one step further by saying that lack of scientific evidence should not be used as an excuse for avoiding taking measures to prevent environmental degradation.

The other principle governs when a party may go ahead with the movement of such LMOs. Advanced informed agreement means exactly that - the party into which the LMOs are to be brought need to know well in advance the nature of the organism, the possible risks involved. Risk assessments - government decide whether or not to import LMOs on the basis of risk assessments, which have to be undertaken in a scientific manner based on recognized risk assessment techniques. However, where there is a lack of relevant information and knowledge, a country can apply the precautionary approach. Under the clearing-house mechanism of the Convention, the protocol has established a Biosafety Clearing-House. This aims to facilitate the exchange of scientific, technical, environmental and legal information on, and experience with LMOs and to assist Parties to implement the Protocol.

## IV. THE DELAY OF THE ENFORCEMENT OF THE PROPOSED LAWS

The Food Administration Unit of the Ministry of Health of Sri Lanka has taken steps to regulate GM food related issues in the year 2001. One major step of this program was to completely ban the import of certain foods without a certificate from an accredited laboratory ensuring that the foods are free of any GMO. However, Sri Lanka revoked the restriction followed by a series of questions raised by the World Trade Organisation whether Sri Lanka had sufficient evidence to prove that GM foods were unsafe (Environmental Foundation Ltd, 2001). State parties to the Sanitary-Phytosanitary agreement are allowed to impose restrictions on the import of products by providing evidence that such products may be cause danger to human health or biodiversity of a country. Article 5 of the agreement provides that these restrictions must be backed with sufficient scientific evidence to justify their imposition (Agreement on the Application of Sanitary and Phytosanitary Measures, 1995). However, Sri Lanka, as a developing country is not barred from applying the “precautionary principle” embodied in Principle 15 of the Rio Declaration.

This principle forms the basis for the Cartagena Protocol on Biodiversity, which states that developing countries may enforce this principle to safeguard themselves from GMOs. Therefore WTO involvement in this ban cannot be justified and that it cannot become involved in this action of the Sri Lankan Government, which was totally taken to protect its consumers from possible negative impacts. Furthermore, Sri Lanka has reportedly faced threats from the US Trade Secretary, who criticised the regulation. It is should be noted that the unwarranted interference of International Organizations in matters related to the sovereignty of Sri Lanka is extremely inappropriate (Environmental Foundation Ltd, 2001).

## CONCLUSION

Modern Biotechnology being one of revolutionary discoveries of the world has created vast developments in many industries. However, the potential threats of such shall not overlooked. Despite the lack of scientific evidence to clearly establish the exact threats of GMO, Sri Lanka has to adopt the precautionary principle following Principle 15 of the Rio Declaration to ensure the protection of bio diversity and human health of Sri Lanka.

However, According to the study done in 2010 on ‘Consumer Attitudes towards Labelling of GM food in Sri Lanka’, it was revealed that most of the Sri Lankan consumers are not aware of GM foods, and yet perceive GM foods to be risky to human health. (Senarath & Karunagoda, 2012). Given the serious health and environmental hazards caused by GMOs it is high time that Sri Lanka implemented projects to enhance the biosafety framework. However, draft Act conscripted over 12 years ago is still in its discussion stages.

Even though existing legislation concerning food and biodiversity facets can be utilised in prohibiting harmful activities, a strong legal framework is necessary in this regard. Among international legislation Sri Lanka has followed Cartagena Protocol as well as Rio Declaration on Bio Diversity to draft required the biosafety framework and the draft Act. Finally it can be stated that Sri Lanka is long overdue with a bio safety law through which the country’s human health and bio diversity can be protected against harmful effects of the domestic synthesis and importation of Genetically Modified Organisms

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# SILENT THREAT TO SRI LANKA'S BIODIVERSITY: LAWS RELATING TO INVASIVE ALIEN SPECIES

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**Abstract** - Incidents such as reduction of forage grasses that can be used by elephants due to rapid spreading of Lantana in Udawalawe National Park and growth of common gorse in Horton National Park indicate that there is a silent threat to the biodiversity of Sri Lanka. The spreading of invasive alien species has been identified as the main reason for the aforesaid threat. Invasive alien species are a part of alien species who will survive, inhabit and spread beyond their areas and purposes of introduction. The impact caused by these species is ranked as the second most serious threat to biodiversity of countries. Invasive alien species assessment conducted in 2016 states that there are 32 flora species and 7 fauna as species named as invasive alien species priorities in Sri Lanka. These species cause impacts in different sectors including biodiversity loss, economic effects and health issues. Invasive alien species (IAS) require expensive control and management with Rs 33 million spent between 2010- 2014, the department of irrigation has incurred costs of Rs 324 million from 2008 on cleaning tanks, canals and water ways. Therefore it is essential to have a specific set of laws to address the mass destruction of biodiversity caused by these species. The existing legal framework does not directly address this growing threat.

The main objective of the research is to distinctly identify the legal principles and laws that are applicable in this area. This area of study provides evidence of identifying the importance of soft law in the process of protecting the environment. The researcher attempts to highlight the contribution of international environmental law in this area and the importance of a synergy between law and biodiversity protection mechanisms. Furthermore the Sri Lankan context is discussed in the research. In Sri Lanka there are certain laws indirectly addressing the issue of invasive alien species. However, the unavailability of a specific legislation to control or eradicate invasive alien

species and to protect the biodiversity of the country undermines the policy initiatives. The author seeks to analyse the existing legal framework and intends to suggest recommendations for effective implementation of the laws. Legal research methodology is followed in this research. Qualitative analysis of data is used in the research. Both primary and secondary data are used in the research. Primary data includes international conventions, laws and Books, journal articles and web articles are used as secondary sources.

The legal framework in South Africa and European Union was used to suggest recommendations. Regulations introduced by other jurisdictions.

**Keywords**- Invasive Alien Species, biodiversity loss, Environmental Law

## I. INTRODUCTION

“Humankind has not woven the web of life. We are but one thread within it. Whatever we do to the web, we do to ourselves. All are bound together. All things connect.”  
(Chief Seattle)

Interconnected and interdependent nature of man and environment reminds us the importance of protecting the environment for the existence of the web of life. Biodiversity protection is important for sustainability of all forms of life. The protection of biodiversity has been recognized as a priority area in International Environmental Law (Justin Pidot, 2006). The threats caused by Invasive Alien Species (IAS) to the biodiversity is irreversible. Most of the developed countries including United States of America and European Union member countries are concerned about this global challenge. Little attention is drawn to the legal mechanisms surrounding this global threat.

Therefore it is important to look at the international legal framework and the Sri Lankan legal framework and identify possible opportunities to successfully control this threat. A synergy between international standards and the Sri Lankan position is considered as an essential mechanism to protect the biodiversity of Sri Lanka and the world at large.

It is pertinent in this backdrop to observe the Sri Lankan position and the legal framework to face this global challenge. Sri Lanka together with the Western Ghats of India is identified as one of the 34 global biodiversity hotspots in the world by Conservation International. World Wildlife Fund's Global 200 has identified Sri Lanka as containing one of the most biologically distinct freshwater, terrestrial and marine eco-regions of the planet. Therefore the biodiversity conservation in Sri Lanka is a paramount interest to protect the biological diversity of the world.

Initial introduction of foreign species to Sri Lanka took place during the colonial period. Developments in agriculture, aquaculture, horticulture and exotic pet industry as a result of liberalization of the economy in 1970s opened up doors to the introduction of invasive alien species to the country. Ministry of Mahaweli Development and Environment has listed the spread of invasive alien species as one of the environmental challenges Sri Lanka is faced with. Invasive alien species risk assessment in 2016 states that there are 32 flora species and 7 fauna species identified as causing threat to the biodiversity. Among them Invasive alien species (IAS) priorities include Water Hyacinth, Giant Salvinia, Guinea Grass, Prickly Pear, Lantana, Rainbow Trout and Tank Cleaner.

It is evident that a strong legal mechanism is essential to address the issue. This area of study has attracted attention of biologists and international legal scholars. However, less attention is drawn to the Sri Lankan legal system. Therefore this research is focused mainly on the domestic legal framework. The author intends to identify the gaps in the existing laws relating to IAS and intends to suggest recommendations. Although there are many areas under the threat of IAS the research is limited to the threats caused by IAS to biodiversity.

## II. INVASIVE ALIEN SPECIES

An alien means an animal or plant that is non-indigenous to a country or region and has been brought from some

other place. An invasive is a species that breeds fast and spreads widely adversely affecting native biodiversity (Gunawardena J, 2001). Invasive alien species can be generally defined as a fraction of alien species who will survive, inhabit and spread beyond their areas and purpose of introduction.

The definitions adapted to define the term invasive alien species exhibit a range of diversity in international and domestic levels. Some countries still have debates and confusions with regard to the basic terminology necessary to define and discuss the threats of IAS (Marc L, 2001). The Convention on Biological Diversity Decision VI/23 defines IAS as species of plants, animals, and micro-organisms introduced by human action outside their natural, past or present distribution (this definition is recognized in Sri Lanka as per the National Invasive Alien Species Policy 2012). Definition used by the European Union is similar to that of the convention (IAS Regulation, Article 3(2)). In contrast to aforementioned definition the definition adapted by United States of America identifies an IAS as a species "whose introduction does or is likely to cause economic or environmental harm to human health" (Executive Order 13112, 2000). Latter definition incorporates a wider scope into the IAS term, main reason can be the high level of risk America face due to IAS.

Invasive alien species include both fauna and flora. These species enter a country by intentional or unintentional methods. Unintentional methods of introduction takes place by national and international trade, shipping, agriculture, fisheries, tourism, horticulture, forestry, construction projects, pet trade, aquaculture, ground and air transport and landscaping.

## III. IMPACTS OF ALIEN INVASIVE SPECIES

Most invasions by alien species have a weak impact, but in some occasions they are capable of precipitating monumental changes to an ecosystem (McCann, 2000). Human ecological mismanagement often leads to the introduction of invasive species (James Ming Chen, 2016; Cox, 1999; Williamson, 1996). World Conservation Union states that the impacts of alien invasive species are immense, insidious and irreversible. Furthermore IAS is considered as one of the greatest vectors of biodiversity loss in the present world (Justin Smith Morrill, 2016). These species are aggressive in claiming new territories, they destroy the areas they claim and they kill silently



without remorse (Kelly J. Cox, 2016). At a global scale, IAS are recognized as the second largest threat to biodiversity and as a major cause of species extinctions (Clavero M, 2005)

Threats caused by IAS to native species include direct exploitation or destruction, competition for resources and hybridisation (Marambe B, 2010). For example, the Tenacious terrapin is a popular pet reptile endemic to North America. The species was introduced to Sri Lanka by aquarists in the 1980's. This species is the only turtle listed in the International World Conservation Union list of the 100 most invasive species on the planet. Sliders depend on local fish spawn and can be aggressive towards other turtles. They compete for food and nesting with vulnerable endemic species.

## IV. GUIDING LEGAL PRINCIPLES

To eradicate, control or regulate the damages caused to biodiversity by IAS requires a clear understanding of applicable legal principles. The legal principles used in this area of study will be analysed in this section. Interim Guiding Principles for the Prevention, Introduction and Mitigation of Impacts of Alien Species is used as a guide.

The main underlying legal principle applicable in this area is precautionary principle. The preamble to the Convention on Biological Diversity confirms this fact by stating that where there is a threat of significant reduction or loss of biological diversity, lack of full scientific certainty should not be used as a reason for postponing measures to minimize a threat. The guiding principles introduced by Conference of Parties (COP) Decision VI/23 encourages State Parties to use a precautionary approach in making laws and policies relating to IAS. The precautionary principle is also incorporated in principle 15 of the Rio Declaration on Environment and Development of 1992 and it is considered as a general environmental principle.

The unpredictability of the impacts on biological diversity by alien species has led to the use of precautionary approach in the IAS laws and regulations. Therefore it is essential for States to make efforts to identify and prevent unintentional introductions and to take decisions to avoid intentional introductions based on the aforesaid principle. Lack of scientific certainty about the environment, social and economic risks posed by a potentially invasive alien species or by a potential pathway should not be used as a reason

for not taking preventive action against the introduction of potentially invasive alien species. Moreover, lack of certainty about the long term implication of an invasion should not be used as a reason for postponing eradication, containment, or control measures (COP 6, 2000).

In this context the control of IAS entering pathways have adapted the precautionary approach. The distinction between intentional introductions and unintentional introductions play a crucial role in understanding the nature of introduction of IAS to a country.

One basic distinction is between alien species brought into a country, area or region intentionally with the knowledge and purpose of an individual or corporate entity and those species brought into a country unintentionally or accidentally through the lack of knowledge or negligence of a person or a corporate entity.

Marc L states that reckless behaviour as a behaviour, where an individual or the representatives of a corporate entity know that there is a substantial risk of introducing alien species. Here this category of acts have a tendency to be included either to intentional or unintentional behaviour depending on the level of awareness of the risk, degree of the risk and the purpose of the classification.

There exists many grey areas in the distinction between intentional and unintentional introductions. The instance where a species is introduced intentionally and subsequently becomes an IAS provides evidence for such uncertainty. The introduction can be made intentionally where the introducer could not foresee such harm. A risk assessment process with an environmental impact assessment that allows introductions only for alien species unlikely to cause unacceptable harm and where anticipated benefits strongly outweigh any actual and potential adverse effects and related costs is important to be used.

Furthermore, the States have the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or to areas beyond the limits of national jurisdiction. This obligation is vested on the States in accordance with Article 3 of the Convention on Biological Diversity and principle two of Rio Declaration in Environment and Development. The acts which are to be recognized as to apply state responsibility includes the intentional or unintentional transfer of IAS to another State and the introduction of IAS into their own State if there is a risk of that species

subsequently spreading into another State and becoming invasive.

## IV. INTERNATIONAL STANDARDS

This part of the paper provides an analysis of the identification of the threat of IAS in the international legal frameworks. On one hand there is a clear availability of soft laws requesting State Parties to adapt laws to control this global threat. On the other hand the lack of complete and coherent laws with regard to IAS the difficulties in perception of everyday human observation of the environment (Marc L,2001)

The Convention on Biological Diversity (CBD) is the main international convention relating to this area. The convention entered into force in 1993 as a result of the United Nations Conference on Environment and Development, held in Rio de Janeiro in 1992. The CBD requires governments to take appropriate measures to conserve biological diversity, ensure the sustainable uses of biological resources, and promote the fair and equitable sharing of benefits arising from the utilisation of genetic resources (McNeely, 2001). The governments have agreed to prepare national biodiversity strategies and action plans, identify genomes, species and ecosystems which are highly important for conservation and sustainable use, monitor biodiversity and factors that are affecting biological systems, establish systems of protected areas, exchange information and rehabilitate degraded ecosystems. Article 8(h) of CBD calls all State Parties to prevent the introduction of, control or eradicate alien invasive species which threaten ecosystems, habitat, or species.

This article is the most important article which specifically identify the threat of IAS. With the lapse of time the international community recognized the requirement of further action in the international arena to strengthen the initial legal step. Global Invasive Species Programme (GISP) was introduced as a result to address the global threats caused by invasive alien species and to provide support to the implementation of Article 8(h) of the CBD. GISP is operated with the cooperation of the Scientific Committee on Problems of the Environment (SCOPE), CAB International, World Conservation Union (IUCN) and United Nations Environment Programme (UNEP).

Furthermore, the International Plant Protection Convention (IPPC) is aimed at taking effective action

to prevent the spread and introduction of pests of plants and plant products and to promote appropriate measures to control them. Although the IPPC does not specifically state about IAS its scope can be expanded to include invasive alien species that may be considered to be a plant pest (global strategy on invasive alien species, 2001).

Many countries have adapted Acts specifically addressing the threats caused by IAS. These countries reveal varying degrees of recognition at the level of law and policy that IAS are a threat to the biodiversity.

### A. European Union

European species and ecosystems are under the threats from IAS. Over 12,000 alien species have been documented to occur in Europe. Roughly 15% of these species are considered invasive, causing adverse impacts on European nature (Vila et al, 2010). Legal framework governing IAS is under the two umbrella conventions, the CBD at the global level and Convention of European Wildlife and Natural Habitats 1979(Bern Convention) at the European level. European Union (EU) Regulation 1143/2014 which entered into force in 2015 is a result of the relation between the Bern Convention and EU biodiversity law. The EU regime on IAS is well tailored and the legal framework provides cooperation among countries and opportunity to implement effective and sustainable measures in the European war against IAS (Epstein, 2015).

### B. South Africa

A specific legislation and set of regulations are enforced in South Africa. The National Environmental Management: Biodiversity Act 10 of 2004 is the main Act which address the threat of IAS. Part 1 of the Act is allocated to Alien species (Article 65-69) Part 2 relates to Invasive species ( Article 70-77). Article 71 restricts the activities of people with listed invasive species. If a person intends to use an invasive species, that person should obtain a permit from the relevant authorities.

A permit is issued only after a prescribed assessment of risks and potential impacts on biodiversity is carried out. A special duty of care is imposed on a person authorised by permit to use a listed invasive species. He is required to take steps to prevent or minimise harm caused to the biodiversity. If a listed invasive species is present on a land, the owner is required to notify relevant authority in writing of such occurrence and should take all steps to prevent or minimise the harm caused to the biodiversity. Failure of

that person to comply with such directive will empower a competent authority to recover all costs of damage. The presence of aforementioned legal provision facilitate the effective implementation of the international standards. These articles highlights the importance of collective effort by citizens and the government. The Biosecurity Unit of the Department of Environmental Affairs is mandated by the Act to manage legislation relating to IAS. Regulations are periodically enacted to face the dynamic threat by IAS.

It is clear that there is a developing interest in the international legal arena to develop effective legal mechanisms to face the IAS challenge.

## V. SRI LANKAN STANDARDS

Constitution of the Democratic Socialist Republic of Sri Lanka in Article 27 (14) under the directive principles of state policy states that the state should protect, preserve and improve the environment for the benefit of the community. On the other hand the Article 28(f) of the Constitution vests a fundamental duty on every person in Sri Lanka to protect nature and conserve its riches. Furthermore, Sri Lanka possess sovereign rights to exploit its own resources pursuant to its environmental policies in accordance with Charter of United Nations and the principles of international law (CBD, Article 3).

The study reveals that a satisfactory policy background to tackle the IAS is present in Sri Lanka. When the legal framework is considered, there are four main statutes which address the issues relating to invasive alien species. One major observation is that there is no clear reference to the term invasive alien species. There are gaps in the existing legal framework which hinders the effective implementation of policy initiatives.

Fisheries and Aquatic Resources Act No. 02 of 1996 for instance was enacted to manage, regulate, conserve and develop the fisheries and aquatic resources. Section 30 of the Act provides that the Minister in Charge of fisheries and aquatic resources and Minister in Charge of trade can prohibit or regulate the export from, or import into Sri Lanka of any species of fish including live fish or any eggs, roe or spawn or any products prepared from such fish, egg, roe or spawn at other aquatic resources for a period specified in the order.

Here the prohibition can be exercised only if the species

had been identified as causing threat to fishes and aquatic resources, the Act does not include provisions to take action for a species that has become or is likely to become an invasive species.

In the Fauna and Flora Protection Ordinance (Amendment) Act No 22 of 2009 under Article 37 requires the authority of a permit to import any animal, spawn, eggs or larvae of any animal. This helps to control the entry of invasive species to the country. Absence of provisions to tackle with a species becoming an invasive species after the introduction to the country under a permit undermines the effectiveness of the law.

Plant Protection Act No. 35 of 1999 intends to prevent the introduction and spread of any organism injurious or harmful to plants or destructive to plants. Provisions are incorporate to prevent entry of any plant or animal that may become a pest or invasive, or potential threat to plant life. Control of an already introduced species or a species that can be invasive with a potential to be introduced is not covered by the provisions.

Marine Pollution Prevention Act No. 35 of 2008 provides opportunity to bring in necessary regulations to control and regulate the release of ballistic waters in to the sea. Despite the laws and policies, the legal framework still remains unclear (Marambe, 2010). A key legislation incorporating a comprehensive legal framework to enhance eradication, control and regulation of invasive alien species is crucial for the implementation of the policies.

Furthermore, Sri Lanka being a signatory to international and regional agreements such as World Trade Organisation Agreement, South Asian Free Trade Area Agreement, International Plant Protection Convention and International Convention for the Prevention of Pollution from Ships requires to establish a clear legal framework. Majority of scholars have pointed out that even though there are better laws and implementation mechanisms in most of the developed countries, there are gaps in the level of compliance by developing countries.

This is a remarkable threat to the biodiversity of the world as majority of world's biodiversity hotspots are located in developing countries. The silent threat that these invasive alien species cause to the rich biodiversity of Sri Lanka which provides a multitude of ecosystem goods and services to more than 20 million of its inhabitants is considered as a crucial issue (National Report to the Conservation on Biological Diversity, 2014).

## VI. RECOMMENDATIONS

Given the inadequacy of the current legal framework to successfully face the growing challenge of IAS in the country it is of vital importance to adapt a legal framework to protect our unique biodiversity. The author recommends the enactment of the draft Invasive Alien Species Act as a step forward to regularize and to supplement the policy initiatives. Presence of an organized set of laws including a statute and regulations is seen as a key to enhance the steps taken to tackle the IAS issue.

Furthermore, it was clear from the study that ambiguities exist in the interpretation of the guiding principles. Clear identification of principles and their application in Sri Lankan context is required.

When the scientific body of knowledge on IAS expands with research, the legal mechanisms must evolve in line with the former. (Nicholas B, 2003). The adaption of timely regulations by carefully considering the scientific experimental results is essential to address the dynamic nature of the threats caused by IAS.

Eradication and control of invasive alien species requires a strong coordination of information between the key stakeholders and the public. Conducting continuous awareness programmes helps in the dissemination of information relating to the identification of IAS, knowledge on the impacts of IAS necessary and the actions that are to be taken.

Use of traditional knowledge, innovations and methods of customary practices of sustainable use of biodiversity of indigenous people on the conservation of biodiversity would help to take productive measures to control IAS spreading in wildlife reserves. Ensuring the rights of indigenous people will provide an opportunity to such people to actively engage in biodiversity conservation.

## VII. CONCLUSION

The silent threat that had become a global challenge for biodiversity loss is discussed in this research. Connection between man and environment should be strengthened in order to protect the biodiversity. The IAS threat discussed in this paper shows an instance where human mismanagement of species had contributed to biodiversity loss. It was clear from the above analysis that the segregated nature of the existing domestic legal framework does not

provide a strong legal mechanism to answer the threats of IAS.

This research initially discussed a requirement of identifying the silent threat to biodiversity of Sri Lanka through an analysis of definitions on the term IAS and the impacts caused by IAS. Secondly, an attempt was made to identify the applicable legal principles to this area of study. Thirdly, a discussion on the international legal instruments and Sri Lankan legal background were considered. It was clear from the study that there is a rapid development in introduction of laws in the international level to enhance the compliance with the conventional obligation under Article 8(h) of CBD. It is evident from the study that the best method to face this global threat is a development of a close synergy between legal mechanisms, policy initiatives and public participation in both domestic and international contexts. Threat of IAS together with impacts of climate change have urged the global community to develop new mechanisms to protect the biodiversity from the modern challenges. Conservation of biodiversity is considered as a common concern of mankind (CBD, 1993). There exists a requirement of immediate action to protect the biodiversity of the world as an obligation to uphold sustainable development, intra-generational and intergenerational equity. This requirement is emphasised by Chen as follows,

“Humanity is now living through the sixth mass extinction where full restoration of such extinction requires 10 million to 100 million years. Therefore the loss of genetic and species diversity is probably the contemporary crisis our descendants will most regret and are least likely to forgive” (James Ming Chen, 2016).

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# PRIVATIZATION OF ARMED CONFLICTS AND INTERNATIONAL HUMANITARIAN LAW

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**Abstract** - From earlier times Private Military Companies (PMC) have become a popular phenomenon in armed conflicts around the world. However thus far, International law have averted from creating a comprehensive legal framework that is especially needed on recognizing the status of people who provides services under PMC to uphold accountability.

Today the International community has laid down several International documents with regard to the subject matter, focusing on responsibility and good practice of the PMCs. However, a question arises on the legality of these documents. PMCs are today playing its role, which has attracted the attention of the International community for the reason of their recent activities around the world. Therefore there is a need of adopting a new legal phenomenon addressing the activities of the PMCs with respect to the laws of International Humanitarian Law (IHL). In light of that, this paper will focus on the overview of the existing International laws with regard to PMCs.

It will also critically analyse the existing International theories and documents in relation to the effects it would have on PMCs, with a special reference to its accountability and criminal responsibility. In this study qualitative information was used for the purpose of critical analysis. Based on such analysis both pros and cons were recognised. As a result it was discovered that there is a necessity to take initiatives to create an inclusive International framework that binds all participants of armed conflicts with reference to principles of IHL.

**Keywords** - International Humanitarian law, Private Military companies, Armed conflicts, Criminal responsibility

## I. INTRODUCTION

The concept of war can be traced down over decades and throughout the time periods its actions are defined by different concepts, customs, laws and actions of war. In warfare outsourcing military services have been occurred in the earlier times of war as well. The concept of mercenaries or hiring parties to conduct warfare for compensation has evolved through time to time. In the recent 20 years there is a particular growth in PMC which grew through the post-cold war era. Since it is an emerging phenomenon it has become a great concern of the International community and there are various problems that should be practically addressed under IHL, when private contractors are hired to replace members in an armed conflict.

IHL is the law of war, and the parties to an armed conflict must adhere to its provisions. But the question is whether these provisions provide an adequate legal framework to ensure PMC compliance with IHL.

Montreux document has defined PMCs as “private business concerns that provide military and/or security services, irrespective of how they describe themselves”. PMCs provide its services related to logistics and administrative support such as, protecting persons and objects, maintenance and operation of weapon systems, prisoner detention and providing advice or training of local military personals.

IHL and customary International laws contain their provisions of almost all the aspects of war. But there are no specific provisions with regard to PMCs. Even though there are no direct provisions it is important to address

the fundamental issues of PMC such as the status of PMC employees, accountability and responsibility on addressing the violations of Human rights and IHL.

## II. METHODOLOGY AND EXPERIMENTAL DESIGN

The study adopted an observational research methodology in order to achieve the objectives of this research. Also a great prominence and reliance are made upon the qualitative method since the core subject matter of this research is grounded substantively in International legal instruments and related academia.

Mixture of both observation and qualitative methods allow the researcher to focus on understanding the phenomenon within its settings and to investigate number of variables. Hence it allows the researcher to have widespread perspective on addressing the issue.

Throughout the research numerous conventional provisions under IHL and customary International laws have been observed and also various documents which have been implemented on addressing the legality of PMCs have been analysed in order to recognise the status of the employees of PMCs at different situations and the state and individual responsibility on the contracting parties.

## III. RESULT

In the research, when observing the legal framework of International law with regard to PMCs was observed with a special reference to Additional Protocol I of the Geneva Convention of 1949. The employees of PMCs do not fall into the definition of mercenaries. Furthermore they are not recognized under combatants to a state party. Therefore such employees are recognised as civilians under IHL.

Secondly with regard to the responsibility of the actions of the employees of the PMCs, states that are contracting with the PMC are responsible for the observation of the activities of PMCs and whether such activities are according to their contract.

Also several downfalls were recognized. Whereas,

- i. There are certain duties that a state has to provide, especially they are fighting for a state but PMCs are fighting for money.

- ii. There is an issue on their transparency and accountability.

- iii. The line behind offensive and defensive gets blurred.

- iv. The Rules of armed conflicts get bent because the employees of PMC do not wait till the other party shoots; they get there and kill the other party first.

The research was carried on to enter into the above said results and it was perceived that even though there is no special reference relating to PMC in IHL, today the International Committee on Red Cross (ICRC) has collaborated with the government of Switzerland and had been able to present an International Code of Conduct for employees of PMC and at present more than 700 PMCs have agreed upon this document. This is a sign of improvement in the International community. It shows that the basic foundation with regard to legal framework on PMC has been laid down.

## IV. DISCUSSION

In any situation of armed conflict every party including PMCs are obliged to respect the provisions of IHL. But at present it can be observed that IHL does not pertain every aspect or cover every situation at war. Therefore it can be said that it provides only a mere guidance for parties.

It is necessary to recognise the status of PMCs in the International context. Whether they should be recognised as mercenaries, combatants or civilians and whether they can be targeted at war, and whom should gain the responsibility of the actions of the PMC employees.

Under IHL privatizing of military activities are prohibited, even though some of the activities are carried done by PMCs in the warfare. IN the question of mercenaries Section 47 of the Additional Protocol I, has laid down a definition for mercenaries and PMCs do not fall under the definition itself. The status of PMC employees differ from according to the situation, where as they are considered as civilians unless they are incorporated in the forces of a state or have combatant functions for an organized armed group belonging to a party to the conflict. When they are protected as civilians they may not be targeted during warfare. and protected against attacks unless they are directly participating in the hostilities. Such employees may directly participate in hostilities by way of gathering tactical military intelligence, operating weapon systems

in a situation of armed conflicts and also when guarding military bases against attacks from the opposite parties. Such acts will make the employees to lose their protection from an attack. And when such employee is captured during warfare directly participating in hostilities they may be tried in a court even though there is no such violation.

Since there are no expressed provisions to regulate PMCs the ICRC and the Swiss government came up with two documents. Firstly the Montreux Document on pertinent International legal obligations and good practice for states related to operations of Private Military and Security Companies during armed conflict.

The issue of this document is that it is not legally binding on the parties. The second document is the International Code of Conduct for Private Security Service Providers. Where its foundation is laid down by the Montreux document. It has been initiated for security service providers to support the rule of law, respect the human rights of all persons and to protect the interest of their clients. According to its preamble the purpose of the code is to set forth a commonly agreed set of principles for PMCs and to establish a foundation to translate those principles into related standards as well as governance and oversight mechanisms.

In both of these documents state responsibility has been recognised and it is the responsibility of states who hire or who makes a contract with the PMC is remain responsible. Such party can be either a state party or an International organisation. It is their responsibility to have precautionary measures to prevent violations into the further by ensuring there are relevant standards are met in law, whether the employees of PMC are following the instructions given by the hired party, a proper training have been given before undertaking a special task and they are responsible for having a mechanism for holding the Employees accountable at any suspicion.

Not only on the hired state but also it is the responsibility of the state whose territory PMCs are incorporated or carry out their missions. Therefore such state party may be responsible to overview whether the domestic laws are followed or not, also responsible to see whether the employees have undergone necessary training required and whether these companies are adopting rules and standards according to IHL and whether the employees are adhering to the contract which they are bound to.

## V. CONCLUSION

Even though PMC has been operating since more 20 years still it is relatively a new phenomenon to the legal framework of the International arena, because there are no direct implications in both IHL as well as in customary International laws.

At present there are several documents incorporated in order to address the obligations and good practice along with IHL. Since the PMC industry is growing day by day there is a necessary of incorporating more statutory bodies; rules and regulations in order to keep these emerging private corporations in line. When considering the practical scenario in 2004, the Abu Ghraib lawsuit was filed against two PMCs CICA and Titan for practising in torture, war crimes, and crimes against humanity, sexual assault and cruel, inhuman and degrading treatment at Abu Ghraib prison. But these Private corporations argued that the subject matter of claim constitute a political question therefore cannot be decided by the courts and also they claimed immunity from being sued before their status as governmental contractors because they were instructed to act upon by the government of United States. Therefore it can be seen that these PMCs used their contracts with the United States as a shield even though there were grave breaches oh IHL and human rights by these companies.

Consequently in the research it can be preserved that there is a need of stable and a wide legal framework to address such issues and also when the statutory bodies are created in order to address the standards, violations, responsibility and the status of PMCs there should be, a vetting procedure for hiring of staff, proper training especially on IHL, internal disciplinary procedures with in PMCs, rules standards in how PMC would contract and also in their operation procedure, also the state parties should have a proper licensing and regulatory system according to IHL and also a special procedure holding violators of IHL who are already retired because when such PMC employee are no longer engaged in direct participation in hostilities they are recognised as civilians and may not be able to be tried for their violations or to impose individual responsibility.

These are crucial aspects on the International law that have been addressed by this research study because every war should be carried out in a human manner and every person is entitled to basic human rights which they are inherited from their birth.



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# ANALYSIS ON DEFORESTATION AND ENVIRONMENTAL LAW IN SRI LANKA

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**Abstract** - Ever since human starts to walk in the earth they had a close relationship with the forest and their daily essentials were provided by the forest. But due to the expansion of civilization, forest lands were destroyed for agricultural purposes, development projects and for timber. Gradually human distant themselves from forests due the technological development they achieved and pay less attention to the protection of forests. Therefore deforestation rate increased.

As an island nation and a biologically hot spot, Sri Lanka had to face the environmental issue, “deforestation”. From the beginning of this nation there were rules and regulations relating to the protection of forests. Though there are laws relating to environmental protection somehow deforestation has become a major environmental issue in the country due to its implication on biodiversity, water cycle, carbon cycle, etc.

This research is carry out to examine “whether laws relating to deforestation are adequate to control the rate of deforestation?” Objectives of this research are to analyze the international and domestic laws prevailing in the country and to examine whether they are adequate enough to mitigate this issue,

Environmental impact of deforestation and finally to recommend solutions by referring into measures taken by other countries. This research would employ a quantitative analysis of primary sources and secondary sources. Primary sources would include conventions, case laws and secondary sources would include textbooks, journal articles and other electronic resources.

**Keywords** - Deforestation, Sri Lanka, Environmental law

## I. INTRODUCTION

According to Food and Agriculture organization of United Nation (FAO), a land area is considered as a forest when it is larger than 0,5 hectares with trees higher than 5 meters and with a crown cover exceeding 10 percent. Importance of a forest cannot be underestimated. Forest provide habitats for millions of species and has a close relationship with water cycle, soil, climate etc. Even though the importance of forests is immense, forest are being destroyed due to the expansion of civilization and agriculture etc. This kind of removal of trees in large scale is called “deforestation”. Causes for deforestation are varying from country to country over time to time in response to cultural social and economic conditions. Deforestation differs from the Forest degradation as in forest degradation it gradually reduces the biomass which is a change with in the forest.

Sri Lanka is an island and one of the Bio Diversity hot spot, according to the International Union for Conservation of Nature<sup>1</sup>. Sri Lankan definition relating to forests is little bit different. It is defined as “a minimum land area of 0.05 hectares with a minimum tree canopy cover of 20% and a canopy height of 3 m”<sup>2</sup>. Forests in Sri Lanka have been classified into 5 categories namely National heritage wilderness areas, conservation forests, reserved forests, village forests and other state forests. As a developing country timber plays a significant role in country’s economy. Sale of timber is a part of the national economy to raise revenue. According to Central Bank

<sup>1</sup> (IUNC, 2014)

<sup>2</sup> (Sara Lindström 2011)

<sup>3</sup> (Sri Lanka UN-REDD Programme 2015)

<sup>4</sup> (Kariyawasam and Rajapakse)

of Sri Lanka statistics, in 1998 the Sri Lankan forestry sector contributed about SL Rs 15 billion to the national economy, which is 2 % of the total gross domestic product (GDP). In early 1800's forest percentage of Sri Lanka was 70% but it has been gradually reduced approximately up to 29% in 2015<sup>3</sup> and 9% of this 29% is primary forests ( the most bio diverse and carbon-dense form of forest.). According to FAO, from the end of 2005 Sri Lanka become the fourth among countries which have worst deforestation rates in primary forest (Bangladesh, Bhutan, Brunei, Cambodia, East Timor, India, Indonesia, Laos, Malaysia, Maldives, Myanmar, Nepal, Pakistan, Philippines, Singapore, Thailand, and Vietnam.)<sup>4</sup> which lost 1% of its forest each year. Therefore concerns about deforestation have been grown in Sri Lanka. During the colonial period of Portuguese, Dutch and English, forests were cut down due to the developments in commercial agriculture<sup>5</sup>. When the British left about 100 years later the forest cover was down at about 50 percent of its former extent<sup>6</sup>. After the independents, timber production got increased and become a mean to fuel. Economic and industrial developments due to these development projects such as Mahawelli project which was implemented with the objective to irrigate large areas of the dry-zone in the northeast had accelerated the deforestation. This project has replaced 2 430 km<sup>2</sup> of the forest. Not only because of development had projects, also because of security reasons government had to remove forest areas during the civil war period. In that period forest was strategically removed to provide less cover for the enemy.

Main four reasons for deforestation in Sri Lanka are Encroachments due to agriculture, gem mining and settlements, Infrastructure development projects, Commercial agriculture ventures and several localized drivers like cattle grazing, cardamom cultivation and forest fires<sup>7</sup>.

In this research paper researches will aim to discuss domestic and international laws implemented in Sri Lanka, steps taken to protect forest resource, environmental impacts due to deforestation in the country and why deforestation has become a major environmental issue and finally international measures taken by Brazil which inherits world most biologically diverse land " Amazon"

and steps taken by the world most powerful country, USA to protect their forest resource will be analyzed and solutions will be recommended by referring in to steps taken by these countries in order to reduce the rate of deforestation.

## II. DOMESTIC AND INTERNATIONAL LAWS OPERATE IN SRI LANKA

99.5% of forests in Sri Lanka belongs to the government, management and protection of the natural forests of the Sri Lankan government fall under two governmental ministries; The Forest Department (FD) and the Department of Wildlife Conservation (DWLC). Before 1970 total requirement of timber was obtained from natural forests<sup>8</sup>. In some years back main task of forest department had been the production of timber, but now it had been converted in to the environmental conservation. Ever since the Buddhism was introduced to Sri Lanka, Sri Lankan kings had imposed sets of restrictions and obligations for the people to avoid any misuse of forest lands. Today starting from the constitution of 1978, Sri Lanka has significant amount of legislatures relating to environmental protection enacted by the government. Under the Constitution there is no mechanism available to protect environment but under the chapter VI, "directive principles of state policies and fundamental duties" it specifically recognized the duty of the state to protect, preserve and improve the environment for the benefit of the community in the Article 27(14) and in the Article 28 it has imposed a duty on citizens to protect nature and conserve its riches. Basically protection for environmental related issues is provided by national environmental Act No.47 of 1980. It provides for the enactment of various regulations against development activities that are deemed to pose threats to the environment.

The Environmental Impact Assessment (EIA) process deserves a special mention in its role as an inhibitor of deforestation and degradation. However the history of environmental policy and law in Sri Lanka goes back much further in history. In 1848, the Timber ordinance No.24 was introduced for the purpose Reservation of forests

<sup>5</sup> (Sri Lanka UN-REDD Programme 2015)

<sup>6</sup> (Sara Lindstrom 2011)

<sup>7</sup> (Sri Lanka UN-REDD Programme 2015)

<sup>8</sup> (Sara Lindstorm, 2011)

largely for timber production. In 1873, Hooker advocated the protection of natural forests above 5000 feet as climatic reserves and in 1938 a law was passed prohibiting the removal of forest above 5000 feet. The corner stone of present law related to forest, Forest Ordinance No. 16 of 1907 (Amended by Act No.13 of 1966) was enacted for the purpose of protecting forests and their products in reserved forests and village forests, again for the controlled exploitation of timber. In 1990, the National Policy for Wildlife Conservation was introduced with the prime objectives of sustaining the ecosystems and ecological processes and the preservation of genetic diversity.

The government also introduced a logging ban which was implemented in all natural forests all around the country under the Forestry Sector Development Program. Apart from the government organization there are Non-Governmental Organization to create environmental awareness of value of trees and forest Ruk Rakaganno is such an organization which is registered under the central environmental authority. When looking into provision of the above mentioned Acts, it is clear that cutting down forest for timber production is not banned in Sri Lanka. Timber is needed to produce products which are required to our day today life. Further wood can be sustainably produced, if it comes from well-managed forest, including plantations grown on previously cleared land. Sri Lanka had ratified international conventions and agreements relating to environmental protection they are convention on Biological Diversity, Ramsar convention which is with the mission of "conservation and wise use of wet land through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world", Kyoto protocol which sets it party state internationally binding for emission reduction targets but it should be noted that no climate policies currently exist to reduce emissions from deforestation or forest degradation in developing countries., United nations World Heritage Convention, United Nations Framework Convention on Climate changers, the Convention on International Trade in Endangered Species of Wild Fauna and Flora and United Nations Convention to combat desertification.

When referring to these local and international instruments, it is clearly manifested that rather than focusing on deforestation they had concern about illegal logging, protection of bio diversity and climate changes etc. It is clear that deforestation is a root cause for loss of bio diversity and climate changes and most of other

environmental issues even though there are laws to regulate illegal timber logging those laws are not sufficient enough to control the rate of deforestation.

### III. IMPACTS OF DEFORESTATION

Major environmental issues in Sri Lanka are loss of bio diversity, deforestation, air, water and soil pollution marine pollution etc. among these issues deforestation becomes significant due to its inseparable impact on other major environmental issues. Forests play major role in carbon cycle, trees absorb carbon dioxide from the atmosphere and release oxygen to the atmosphere and helps to keep global climate in balance. Forests are the major carbon dioxide storage center but, when trees are cut down all the stored carbon dioxide is released back into the atmosphere, carbon dioxide is a greenhouse gas which comparatively has a higher ability to absorbs much heat than other gases in the atmosphere. Deforestation is one of the main causes which enhance the greenhouse effect which imbalance the local and regional climates.

Trees also help to balance the water cycle by regulating the water level in atmosphere. Most of the rivers and streams in Sri Lanka are originated from the central hill. Trees and forested areas plays important role in determining local climate and precipitation and maintaining the soil conditions that determine stream flow and even area evaporation rates. Therefor loss of a forested area will effect on how the water cycle transfers water between the ground and atmosphere.

Further forest provide habitat for wildlife and also for indigenous tribes who are depending on them. Sri Lanka is a home for 3,210 flowering plant species, and out of that flowering plants and species 916 are endemic. Unfortunately due to the reasons like deforestation biological wealth in the country is in a threat. Surveys had found out that 17 of Sri Lanka's frogs have disappeared in the past decade and another 11 species face imminent extinction unless their habitat is protected. As above mentioned loss of bio diversity is a major environmental issue in the country and one of main reason for this issue is deforestation. Forests work as an anchor topsoil to the ground. The dense forest vegetation act as a natural shield that decreases splash erosion during intense rainfalls while dispersing the droplet energy and covering the ground in a layer of protective leaf litter.

Apart from the environmental implications deforestation

in Sri Lanka has caused ill effects such as flooding, landslides and soil erosion. When considering about these fact it is clear that the implementation of new law is an immediate necessity to mitigate this environmental issues.

## IV. RECOMMENDATIONS

Deforestation and degradation are complex problems not only to Sri Lanka but to countries all over the world. Government of Sri Lanka with International Environmental organizations has taken several steps to address the problem over years by establishing national parks, reserves and sanctuaries. As an example Sinha raja Forest Reserve, which was established in 1978 to protect the nearly extinct tropical lowland rain forest, was flagged as a World Heritage Site in 1988. Deforestation rate of the southern mountainous regions in country is comparatively low when comparing with the northern part of the country due to the nature of environmental protection in that area. Though there are laws relating to the environmental protection there insufficiency is clearly manifested when comparing deforestation rate in Sri Lanka.

Different countries have used different methods to regulate deforestation depending on national capabilities, deforestation patterns and forest characteristics.

### BRAZIL

It is important to examine the measures taken by Brazil to protect Amazon rain forest which is the most biologically diverse place on the Earth. Since 1970, over 600,000 square kilometers of Amazon rainforest have been destroyed<sup>9</sup>. In 2002 Brazil launched tropical forest conservation project known as ARPA (Amazon Region Protected Areas). Brazil announced a national plan to reduce its deforestation rate 80 percent by 2020 and later made this commitment part of its national law.

Between 2005 and 2010, Brazil nearly met its goal a full decade ahead of schedule. Data from 2009–2010 showed that Brazil's area of deforestation, which averaged 19,508 square kilometers (km<sup>2</sup>) per year during the baseline decade of 1996–2005, had dropped 67 percent, to just 6,451 km<sup>2</sup>. UCS analysis of this change, using a formula

for converting deforested area to CO<sub>2</sub> emissions based on the work of the research institute IMAZON, estimated a reduction in Brazil's global warming pollution of nearly 1 billion tons but balancing economic growth with the preservation of Amazon has become a challenge for the Brazil. Unfortunately in 2015 rate of deforestation rose again, nearly two million acres of the forest from August 2015 to July 2016 were cut down. That is a jump from about 1.5 million acres a year earlier and just over 1.2 million acres the year before that, according to the estimates of Brazil's National Institute for Space Research<sup>8</sup>.

Implementing laws alone cannot stop the deforestation government need to do their part, starts with cracking down on corruption and ensuring fair enforcement of forest conservation rules. Corruption fuels illegal logging and unsustainable forest management.

### USA

In the United States, laws like the Endangered Species Act, the Wilderness Act, the Lacey Act and the Roadless Rule had helped to protect their forests resource and stop illegal wood products from entering in to the U.S. marketplace. Under the Roadless Rule, United States Department of Agriculture adopted this final rule to establish prohibitions on road construction, road reconstruction, and timber harvesting in inventoried roadless areas on National Forest System lands. The intent of this final rule is to provide lasting protection for inventoried roadless areas within the National Forest System in the context of multiple-use management<sup>11</sup>.

Further according to the Intergovernmental Panel on Climate Changers (IPCC) some countries monitored about the deforestation rate by examine the carbon emission rate.

“Several developing countries, including India and Brazil, have systems in place for national-scale monitoring of deforestation. While well-established methods and tools are available for estimating forest carbon stocks, dedicated investment would be required to expand carbon stock inventories so that reliable carbon estimates can be applied to areas identified as deforested or degraded through

<sup>9</sup> (Rhett Butler, 2017)

<sup>10</sup> (Hiroko Tabuchi, 2017)

<sup>11</sup> (Roadless areas convention,2001)

<sup>12</sup> (IPCC, 2006)

<sup>13</sup> (Greepeace,2010)

remote sensing. With sound data on both change in forest cover and on change in carbon stocks resulting from deforestation and degradation, emissions can be estimated using methods described by the new IPCC Inventory Guidelines<sup>12</sup>

When there is a monitoring method countries can estimate deforestation rate daily even provision wise then they can pay much attention to the land areas which have higher deforestation rate and then they can find solutions.

Apart from the government intervention public also need to play active role to mitigate this major environmental issue. Companies can make an impact by introducing “zero deforestation” policies that clean up their supply chains. That means holding their suppliers accountable for producing commodities like timber, beef, soy, palm oil and paper in a way that does not fuel deforestation and has a minimal impact on the climate. Such attempts have been taken by companies like Nestle and Mac Donald’s. Nestle had agreed to stop purchasing palm oil from sources that destroy Indonesian rainforests.<sup>13</sup> Companies can maximize the use of recycled wood, pulp, paper and fiber in their products.

When a tree is cut down another can be planted in the same place. Then it will control the loss of the tree which is cut down. Those who are engage in agriculture field can participate in putting a dent in deforestation by rotating crops. It is suggested to replace the habit of using different portions of land each year with using the same portion of land to plant different crops. This practice has proven effective in maintaining soil fertility. Farmers may also embrace many other options, such as high-yield hybrid crops and hydroponics, which relies on a method of growing plants using mineral nutrient solutions instead of soil.

## V. CONCLUSION

Forest is the most biological diverse biome on the planet we call Earth. It is home to an abundance of organisms that depend on it for food, shelter, etc. If we destroy it, we will inevitably lead numerous species into extinction which disrupts large ecosystems which in turn leads other species into extinction. The biosphere of Earth will be severely damaged if we remove the ecosystem. We still have quite a lot of forests in our country, but we need to be wise to manage the forest. If we are smart enough to send a man to the moon and build skyscrapers, we should be

smart enough to find a sustainable way to work with the environment and stop cutting down trees. There are too many things to be sacrificed for this earth such as trees, soil, air and animals so think again if you want to make a business that need a forest to be sacrificed this world is crying already.

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Sri Lanka UN-REDD Programme. DRIVERS OF DEFORESTATION AND FOREST DEGRADATION IN SRI LANKA: IDENTIFICATION OF KEY POLICIES

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# LIABILITY FOR OMISSION IN PROSPECTUS UNDER THE COMPANIES ACT OF 2007: NEED FOR REFORMATION

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**Abstract** - Prospectus is a legally mandated document which reflects the status of a company which has offered securities to the public. Based on the information provided in the prospectus, the investors make their decisions as to whether or not accept the offer and purchase securities of that enterprise. As a result of this vital role played by prospectuses in inducing investors to invest in securities, it is of immense importance that the prospectus not only provide accurate information, but also do not omit any fact which is essential to make a proper decision.

However, under the company law of Sri Lanka, although the liability for misstatements could be imposed on persons who are responsible for making the prospectus, there cannot be found any provisions which provide for liability for omissions. Nonetheless, with reference to other legal systems in the world such as India, the United Kingdom (UK), and the United States (USA), it can be seen that provisions relating to liability for misstatements as well as for omissions are included in their relevant legislations. Hence this can be identified as a loophole in Sri Lankan company law regime owing to which a subscriber who has suffered a loss as a result of any omission lacks an effective legal remedy to claim compensation from the party who is responsible for such an omission.

Therefore, this study recommends that the existing company law of Sri Lanka should be amended in order to include provisions relating to liability for omissions as well. The author uses primary and secondary data such as Acts and Statutes, judicial decisions, and web articles to achieve the objectives of analysing the company law regime of Sri Lanka in relation to the liability for omissions in prospectuses with a comparative analysis of other jurisdictions; India, the UK and the USA.

**Keywords** - Company Law, Prospectus, Liability for Omissions, Sri Lanka

## I. INTRODUCTION

Prospectus is a form of legal document issued by a company offering securities to general public or a part thereof. As pointed out by the court in *Possfund Custodian Trustee Ltd and another v Diamond and others* [1996] 1 WLR 1351, the main purpose of issuing a prospectus is to;

"...[P]rovide the necessary information for an investor to enable him to make an informed decision as to whether or not accept the offer made by the company to take shares on the proposed allotment...(emphasis added)".

Hence it is of paramount importance that prospectuses not only carry accurate information, but also do not omit any substantial fact about the true status of the company which has the gravity of affecting the decision of the investor to purchase securities of the company. In Company Law of many countries in the world including the United Kingdom (UK), the United States of America (USA) as well as our neighbouring country India, both of those aspects relating to the content of the prospectus are successfully addressed in their respective legislation. However, under Companies Act No 7 of 2007, which is the main piece of legislation governing the conduct of business enterprises in Sri Lanka, the liability for an omission of a material fact in the prospectus is not properly being addressed. Thus, it can be considered as a loophole in Sri Lankan Company Law regime which provides an unjustifiable opportunity for companies to mislead the public and make them purchase securities through concealment of important information.

The primary objective of conducting this study is to propose an amendment to the Companies Act of Sri Lanka



to provide for the imposition of liability for omissions in prospectuses.

In order to achieve that primary objective, several secondary objectives are set; namely, to analyse the company Law regime of Sri Lanka in relation to the omissions in Prospectuses, and, to find out the legal status for omissions in prospectuses in other jurisdictions such as the UK, the USA, and India while emphasising the importance of imposing liability for such omissions.

## II. METHODOLOGY

This study was conducted as a doctrinal legal research based on qualitative data extracted from primary and secondary sources. Existing legislation such as Companies Act No 7 of 2007, Sri Lanka, and other relevant legislation relating to company law in other countries were used, along with judicial decisions, as primary data to achieve the objectives of this research. Moreover, sources such as books and journal articles, both in and outside Sri Lanka, were reviewed to gather secondary data which provide necessary information regarding the research problem.

## III. RESULTS AND DISCUSSION

The present Company Law of Sri Lanka is mainly governed by the Companies Act No 7 of 2007 which repealed the provisions of Companies Act No 17 of 1982.

Other than that, as discussed later in this paper, the law of England applies to commercial matters in Sri Lanka by virtue of section 3 of the Civil Law Ordinance No 5 of 1852.

### A. Imposition of Liability for Omissions

#### 1) Sri Lanka:

Part IV of the Companies Act No 7 of 2007 deals with the matters relating to the issue of prospectuses, including the imposition of civil and criminal liability for untrue statements. According to section 41 of the Act, civil liability could be imposed on a person who is responsible for issuing the prospectus, to pay compensation to any subscriber who has suffered any loss or damage by reason of any untrue statement contained in such a prospectus. Similarly, criminal liability could be imposed on a person, under section 42 of the Act, for authorising the issue of a prospectus in which an untrue statement was included. Moreover, an untrue statement is defined in section 44

of the Act, as a statement which is of misleading nature. However, as can be seen, although the Companies Act No 7 of 2007 of Sri Lanka makes explicit reference to imposition of civil and criminal liabilities for inclusion of untrue/misleading statements in prospectuses, it does not make any clear reference to liability for omissions of material facts in a prospectus which have the potential of making an impact on a subscriber's decision as to whether or not purchase securities which are offered to the public by the company. Therefore, the company law of Sri Lanka appears to be silent with regard to the imposition of liability for omissions in prospectuses.

However, the situation is rather different in company law of other jurisdictions in the world such as India, the UK, as well as the USA where, in addition to untrue/misleading statements, the liability for omissions can also be attributed to persons who are responsible for issuing prospectuses under their respective legislation.

#### 2) India:

The law relating to issuing of prospectuses in India is mainly provided in the Companies Act No 18 of 2013, which repealed the provisions of Companies Act, 1956 in a partial manner. Section 36 of the above Act reads as follows;

“Any person who, either knowingly or recklessly makes any statement, promise or forecast which is false, deceptive or misleading, or deliberately conceals any material facts, to induce another person to enter into, or to offer to enter into...any agreement for, or with a view to, acquiring, disposing of, subscribing for, or underwriting securities... shall be liable for action under section 447 (Punishment for fraud).”

Thus, it can be seen with reference to the wording of the above provision that the legislature of India has intended to extend the liability of a person who is responsible for issuing prospectuses not only to misstatements, but also for deliberate omissions.

Moreover, Section 35 of the above Act imposes civil liability for misstatements in prospectuses. Here again, the liability can be imposed not only with regard to misstatements but also for omissions in a prospectus.

Furthermore, criminal liability can also be imposed on persons who authorise the issue of a prospectus for misstatements contained thereof, as well as for omissions of material facts, under section 34 of the Act.

### 3) The United Kingdom (UK):

The situation appears to be the same in the UK as well. There, the matters relating to the content of prospectuses are regulated by Financial Services and Markets Act 2000 c.8ff. Under sections 80 and 81 of the Act, it imposes a general duty of disclosure of all such information that investors and their professional advisers would reasonably require in making an informed decision regarding purchasing securities of a company. It is further provided under section 90 of the Act that if any such information as required by sections 80 and 81 is omitted, any responsible person is liable to pay compensation to a person who has suffered any loss owing to such an omission in the prospectus.

Moreover, the duty to disclose every fact without any omission was also identified in number of common law cases. For example, in *New Brunswick and Canada Railway and Land Co v Muggeridge* [1850] 62 ER 263, it was observed by the court that;

“...[p]ersons who make prospectuses are not only bound to state everything with strict and scrupulous accuracy but also not to omit any fact within their knowledge, the existence of which might affect the nature of privileges and advantages which the prospectus holds out as inducement to take shares...(emphasis added)”.

Furthermore, in *Central railway Co of Venezuela v Kisch* [1865] 46 ER 584, Lord Chelmsford held that “...no concealment of any material fact ought to be permitted...”.

A question that does deserve attention is that whether the provisions of the Financial Services and Markets Act 2000 of the UK regarding the liability for omissions in prospectuses apply to Sri Lanka through the gateway of section 3 of the Civil Law Ordinance 1852 which states that the law of England should be observed in all commercial matters. In decided cases such as *Duhilanomal and Others v Mahakande Housing Co. Ltd* [1982] 2 SLR 504, *Lily M. de Costa v Bank of Ceylon* [1969] 72 NLR 457, and *Amarasekere v Mitsui and Company Ltd. and Others* [1993] 1 Sri LR 22, it was held by the courts that the law of England, including statutory law applied to Sri Lanka with regard to commercial matters, in the absence of any enactment in Sri Lanka governing the same aspect. However, due to the fact that the present regime of company law of Sri Lanka operates under such an enactment (i.e. Companies Act No 7 of 2007), the importation of provisions of Financial Services and

Markets Act 2000, UK to supplement the provisions of a well-established Act in Sri Lanka is highly debatable.

### 4) The United States of America (USA):

The main piece of legislation which deals with the requirements of issuing prospectuses in the USA is the Securities Act of 1933, under section 11 of which a general obligation is imposed on persons who are responsible for issuing a prospectus to ensure that it does not only carry any untrue statement, but also does not omit any material fact which is required to make an informed decision, while giving an expressed right to any buyer who has suffered any loss due to such an untrue statement or omission to bring a legal action against any responsible person.

Moreover, section 12 of the Act provides for the imposition of civil liability for untrue statements as well as for omissions of material facts on any person who offers or sells a security.

In addition, Rule 10b of the Securities and Exchange Commission, USA imposes a general obligation on every person not to use any deceptive and manipulative devices in connection with the sale or purchase of any security. In particular, it makes it unlawful under part (b) to omit any material fact which is necessary to make the statement made, not misleading. This rule was given judicial recognition in cases such as; *Chiarella v. United States*, 445 U.S. 222 (1980), *Basic Inc. v. Levinson*, 485 U.S. 224 (1988), and *United States v. O'Hagan*, 521 U.S. 642 (1997).

Thus, it is evident that, by referring to aforementioned legislations, unlike in company law of Sri Lanka, which is mainly operated under the Companies Act No 7 of 2007, in India, the UK, and the USA, the statutory law explicitly provides for the imposition of liability on persons responsible for making prospectuses, not only for untrue/misleading statements, but also for omissions of material facts, which are necessary for the proper decision making.

## IV. CONCLUSION AND RECOMMENDATIONS

A prospectus is a document required by law to be issued along with an issue of securities of a company to enable the investors to make an informed decision as to whether or not make a subscription. Due to the fact that an investor relies on the information provided in the prospectus to a large extent in making his/her decision in

purchasing securities so offered, the information provided in the prospectus should, not only be accurate but also be sufficient. Thus, it is vital that the law of prospectus explicitly provides an effective remedy for subscribers who have purchased securities not only based on untrue/misleading information, but also unknowing the true facts of the company which were omitted in the prospectus and consequently suffered a loss/damage.

It appears that the Companies Act No 7 2007 which is the main piece of legislation governing the commercial matters of Sri Lanka, imposes liability on persons responsible for issuing prospectuses only for untrue/misleading statements contained thereof. Hence, the liability for omissions of material facts appears to be left unregulated.

However, in countries such as India, the UK, and the USA, liability for both misleading/untrue statements as well as for omissions of material facts can successfully be imposed under their respective legislations.

Although it is arguable that, as discussed above, by virtue of section 3 of the Civil Law Ordinance 1852, the law of England relating to the imposition of liability for omissions could be imported to supplement the company law of Sri Lanka, a legal system requires a precise set of rules of its own to operate effectively.

Therefore, this study recommends that an amendment to the Companies Act No 7 of 2007 should be made in order to include provisions relating to the liability for omissions of material facts in prospectuses to protect subscribers from any loss/damage by allowing them to make an informed decision after being aware of all the necessary information regarding the true status of the company, in which they are about to invest.

By considering all the above analysed jurisdictions (i.e. India, the UK, and the USA), this study suggests that the Companies Act No 18 of 2013 of India shall be taken as a model in achieving the object of amending the Companies Act No 7 of 2007 of Sri Lanka as the Indian Companies Act appears to contain similar provisions as in the Sri Lankan Companies Act with regard to matters relating to prospectuses. Moreover, unlike in other jurisdictions where matters relating to issuing of securities and matters relating to conduct of business enterprises are mainly governed by different legislations, both in India and Sri Lanka both of those aspects are mainly governed under a single piece of legislation which is the Companies Act.

Thus, this study recommends that the sections 41 and 42 of the Companies Act No 7 of 2007 of Sri Lanka should be amended in accordance with the sections 35 and 34 of the Companies Act No 18 of 2013 of India to impose civil and criminal liability for omissions of material facts in addition to misstatements in prospectuses on persons who are responsible for issuing the prospectus, namely; directors of the company, promoters of the company, as well as any other person who has authorised such an issue, in the already prescribed manner similar to misstatements to make them liable to pay compensation to the aggrieved party in relation to the civil liability; and, with regard to criminal liability, to make any person who has authorised the issue of the prospectus, be guilty of an offence punishable by a conviction to a fine not exceeding five hundred thousand rupees or to an imprisonment for a term not exceeding two years, or to both, as decided by a competent authority, similar to that of the criminal liability for misstatements.

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# INTERNATIONAL HUMANITARIAN LAW AND REGULATIONS TO PREVENT THE DEATHS AND INJURIES OF THE CIVILIANS DURING AN INTERNATIONAL ARMED CONFLICT

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**Abstract** - Armed forces in any country are expected to use special expertise knowledge and skills to save the dignity of the state and its citizens without being negligent or without having failure and inappropriate commanding orders. Therefore it should have a serious examination on the existing laws and especially on the Geneva Convention -4, Article 3 which has specially focus on the non-combatants in international conflict. Even though there have been practicing numerous types of laws and regulations, it is been noticeable that these are somewhat ineffective in the present war field. This could leads to a zero respect towards the law. Inasmuch the objectives of this paper article efforts to examine the required standard of care by the international authorities, consider on the several articles and currently existing laws and regulations that are specially regard on the protection of unarmed civilians also, to identify the finding loopholes of the existing laws and provide suggestions on the existing laws. This research is a doctrinal type of research which reviews some past literature, analysis of past case studies and books in the area of the international humanitarian law. In the long run, there are millions of innocent civilians have been trapped in many war effecting areas helplessly without ant wrong on their hands. Therefore it is one of a massive and also an important duty to rescue them immediately as soon as possible. The International Humanitarian Law as the supreme law for the international armed conflicts is having that noble duty protect innocent civilians in endanger no matter in any circumstances occurs.

**Keywords** – International Humanitarian Law, Civilians, litigations, reforms

## I. INTRODUCTION

The requirement of protection for children, women and other civilians who are not engage in armed conflicts is a massive onerous action which must do in the field of international humanitarian law. Here for one fact is that these innocent people does not know anything about what military tack ticks are or how the armed forces deals with weapons and their other activities. Specially, the small children and sometimes women are also does not have such experiences to deal with such a situation. Therefor their protection is in a somewhat danger. Then in such situation when the state and the international community is also unable to protect the innocent civilians then for sure they are helpless. So there must have a more influential mechanism to protect the civilians and to establish the core norm of the IHL.

## II. METHODOLOGY

This paper article reviews some past literature, analysis of past case studies and books in the area of international humanitarian law with the main objective of examining the required standard of care by the international authorities , which is one of a main factor of killing innocent civilians

who are non-armed, with the consideration of several articles and currently existing laws and regulations that are specially regard on the protection of unarmed civilians also, identify the finding loopholes of the existing laws and provide suggestions on far more progressive academic expressions on this issue, would to protect rights of human mankind and establish, ensure the sovereignty of law among all nations.

### III.DISCUSSION

In an ancient treatise called “the art of the war”, written in 500 BC, by the Chinese writer Sun Tsu expressed his purport that, wars must be limited to military urgency, and the prisoners of war, the wounded, the sick, and civilians should be dispensable from a war. Likewise the similar idea can be found in many ancient writings such as code of Manu in 200 BC. these ancient records are testify that the “power” can be obtained under the name of “war” but, then not to destroy the rights of human beings, specially their right to life of the people who are not engage in armed conflicts. This is the core notion which is repeatedly followed and carried out by generation to generation. So same as the ancient era and now, in the modern international humanitarian law (IHL) has been especially look forward in setting the guidelines to be followed during war and armed conflict as a way of protecting the innocent civilians.

In a society, primarily the civilians and those are not actively involved in a war including medical personal and organizations providing humanitarian relief services are also covered under IHL, therefor it is an important matter of deal with the protection of these vulnerable group at the war field. However when concern on the latest and past war reports which are calculated the civilian injury and even the deaths, it is intensively affirmed that, even at least to a great extent humanitarian law has been greatly ineffective. (international humanitarian law 2008 )even though it is to be noted that, in the field of IHL the existing statutes, conventions, treaties and other enforceable mechanisms are in somewhat extent effectively contributing its service but still , concern about the enhancing wars in the international arena it is not satisfactory even up to now.

When concern about the modern IHL context the Geneva Convention in 1949 is playing a major role in the international arena, also it is important to understand that the four Geneva conventions and the additional protocols of the Geneva convention are highly effective

and have imposed very important rules and regulations to international or internal armed conflicts. Also they have up bring certain important standards to the battle field to follow during the war.

The first Geneva convention “for the Amelioration of the Condition of the Wounded and Sick in Armed Forces in the Field” The Second Geneva Convention “for the Amelioration of the Condition of Wounded, Sick and Shipwrecked Members of Armed Forces at Sea” replaced the Hague Convention of 1907. It was the first Geneva Convention on the protection of the victims of maritime warfare and mimicked the structure and provisions of the First Geneva Convention. The Third Geneva Convention “relative to the Treatment of Prisoners of War” replaced the 1929 Geneva Convention that dealt with prisoners of war. The most important convention which is related to this article is the Fourth Geneva Convention “relative to the Protection of Civilian Persons in Time of War”. It was the first Geneva Convention not to deal with combatants, rather it had the protection of civilians as its subject matter.

The 1899 and 1907 Hague Conventions had already contained some provisions on the protection of civilians and occupied territory. Article 154 specifically provides that the Fourth Geneva Convention is supplementary to these provisions in the Hague Conventions. The article 3 of the fourth Geneva Convention is especially important as it clearly states the provisions that are to guide conflicting parties (states) regarding the treatment of parties (civilians) not directly involved in the conflict. It had become apparent that whenever there was a conflict, it is mostly the innocent civilians that suffered. The civilians are often terrorized and is categorical that persons objection. The treaty is categorical that persons who may not be actively involved in conflicts and hostilities, especially civilians, members of the armed forces who have since retired from active duty and members of the combat (hors de combat) as a result of detention, sickness or wounding are to be accorded special treatment.

They are all to be treated humanity without any kind of discrimination on the basis of race, color, sex, religion or even faith. Also the protocol 1 expands the protection for the civilian population as well as military and civilian medical workers in international armed conflicts in addition, Arts.15,79,Arts.76-77 give special protection to women, children and civilian medical personnel and journalists. Arts.17, 81 are given permission to ICRC, national societies or other impartial humanitarian organizations authorized by parties to the conflict to

provide assistance. Also the article 35 prohibits “caused superfluous injury or unnecessary suffering” as well as that “caused wider spread, long term and severe damage to the natural environment”. In the protocol II specifically prohibits violence to the life, health and physical or mental well-being of people. In particular, it provide that children are to evacuated to safe areas when possible and reunited with their families Also the principles of IHL, has given a wider space to principle of self-defense which is also constitute in the Article 51 of the UN Charter, the principle of proportionality states that, even where there is a clear target on terrorists, it is prohibited to attack if it is a risk to civilians or civilian property, being harmed is larger than the expected military advantage.

According to the principle of distinction, the parties to a conflict, must at all-time distinguish between civilians and combatants, and attacks must only be directly on the combatants. The war involving parties must have a clear distinguish between the civilian objects and military objects. Attacks should be strictly forward to the military objects.

When concern on these legal provisions which are deals with the protection of the innocent civilians but, still it can't be said that these provisions or the principles are highly influential when it comes to it practical aspect. Also, it could be agree when it comes to its theoretical scenario that this can be well fitted and fare enough to deal with any war but, unfortunately we need a solution for the practical sense and that's what always happens in this world even just right now as well so, this is the most crucial point of all.

#### IV. RECOMMENDATIONS

Concern with the recommendations, it is important to understand that previously mentioned documents [Geneva Convention and the additional protocols] are even though they are very important but, still its enforceable mechanism is still not effective. Actually in the practical scenario it is very difficult to find out that even how many civilians or military personals are have been died during the war, it is so difficult to find the exact information in the field of war. But concern reported war deaths of civilians and other war crimes it is understandable that still the war crimes and civil attacks are happening. Therefore first there must have a developed communication media with the military groups, especially nowadays with the terrorist groups such as ISIS, Taliban and many others. Because it can constitute

a further more developed strategic plans with these sort of military groups. And also another major fact is that the IHL must applied for in an equal manner to everywhere the problem is that the international community is willing to apply the international law where their own interest is with , other states who may have the less interest they pay less attention and the neutrality may applied. This imbalance of the attention can lead to a massive conflicts. For an example the western approach more in to deal with the middle-east countries who are blessed with petroleum ant other resources. But in all around the world there are conflicts may occur at least in the domestic level but, at the end same featured people were killed helpless.

This is a huge week point that can be seeing in the international enforcement bodies. Also the international community they sometimes contributes unnecessary attention towards some internal wars and make them more worst. Also there must have a very strong judicial frame work that can be deal with these sort of issues very sensitively. It can be seeing that international courts such as ICC provides more effective judgments but, even though that still the same type of crimes are happens also in further more developed manner. It shows that the respect level towards the law, so this is a fact that must questioned. Another progressive solution is that deal with the terrorist groups with the concern of their religious or cultural background, for an example this can be done with the Islamic extremist groups, it is not a peaceful talk which is to stop the war but, it should be directly aimed to survive civilians who are going to be their targets.

So the help of the Islamic leaders who are having the great personalities and who have the respect of their people addition to that point it must understand thoroughly, in the history most of the wars happened regarding religion or some sort of ethnicities, for an example the crusade war happened among two religion and it killed thousands of people from both sides. So it can be said that people are more serious with the religion but this is also can be successes in to some extent concern about the latest middle -east crises. Finally the states are having the most influential power which should have to protect their civilians but, in practically the states are unable of protect the civilians during the war period because their all the attention is goes with the war. For an instance the Azard's government in Syria didn't take early measurements to protect civilians before the war get worst so, now it can be seeing the bad repercussions of it. So reinforcement of the state parties is the most influential mechanism what the international community can be done. For that

a particular contract should be introduced that the both parties must be responsible regarding the civilians, it must have a binding liability towards them. Then regarding the civilian matters the utmost interference should be obtained by the international authorities, the civilians must get the temporary citizenship by the other countries which are safe enough, the refugees shouldn't be torched physically and specially mentally and chased out by those countries just like the present USA government does.

## V. CONCLUSION

Due to the increases of world war conflicts of all around the world, to mitigate the risk of damage to the civilians population, it is not enough to constitute many Acts, statues or any other documents which does not have any influential power because, in practically states are very lazy to follow all the laws and rules accordingly. Therefore it is an urgent need to understand about the need of an effective mechanism which can highly influence to decrease the civil injuries. On the other hand the states have their own responsibility to take relevant measurements and the decisions over their states. That is called the state sovereignty which a state must have absolutely. But it doesn't mean that it can go beyond the internationally recognized laws and regulations. This fact must be understood by all nations for the betterment of their own people. Because this world is not useful without its own mankind.

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# A GAME OF TITLES: THE EFFECTIVENESS OF THE IMPLEMENTATION OF THE CURRENT LAND TITLE REGISTRATION PROGRAMME UNDER THE REGISTRATION OF TITLES ACT NO. 21 OF 1998 IN SRI LANKA

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**Abstract** - A definite title to one's land is essential before one can reap the full benefits of such land. In order to obtain a definite title to a land, a landowner must register such land legally in order for him to fully enforce his rights to such land. The law relating to the registration of lands in Sri Lanka at present is governed under the law relating to 'registration of deeds' system in the Registration of Deeds Ordinance 1927 Sri Lanka.

However, this system of registration of lands is fundamentally flawed and therefore was replaced with 'registration of title' system by the Registration of Titles Act No 21 of 1998. The land registration programme, popularised as 'Bim Saviya' was the programme implemented under this Act entrusted with the main task of registration of lands in Sri Lanka and issuing title certificates to such lands. However, this programme, ever since its implementation has shown a very slow progress in the registration of lands in Sri Lanka.

The objective of this study is to analyse the current land title registration programme in Sri Lanka in order to ascertain its effectiveness in registering lands and issuing title certificates to lands. The research uses a mixed approach of analysing both doctrinal and non-doctrinal data pertaining to this area, the non-doctrinal approach will analyse quantitative data collected so as to identify the loopholes in the present land registration programme

implemented under the Title Registration Act and thereby to provide effective solutions to the slow procedure in land title registration.

**Keywords** - Title Registration, Land law, Sri Lanka, Bim Saviya

## I. INTRODUCTION

"No one shall be arbitrarily deprived of his property." So declares article 17 of the 1948 Universal Declaration of Human Rights. Land is a fundamental resource and its owner can only enforce its full when the rights to land are registered. In order to safeguard one's property, a person needs to be able to prove his or her ownership to such property. Land is undisputedly one of the key property components that a man can own. Therefore, the ability to prove the ownership of one's land is essential so as to ensure that one maybe able reap the full benefits of such land. In order to prove an ownership to a land, a land must be registered. The present system prevalent in Sri Lanka to register lands is the procedure present under the Registration of deeds ordinance, however this system is flawed and therefore a new system for the registration of lands has emerged with the Registration of Title Act No. 21 of 1998. The registration of title system has now become a widely used system in land administration and has been successfully implemented in many countries such as

Thailand, Malaysia, Australia, New Zealand to name a few, due to this reason both the United Nations and the World Bank recommends the adoption of a title registration system for effective land registration. The need for a proper land registration system in Sri Lanka led to the formation of “Bim Saviya” a program that is implemented under the provisions of Registration of Title Act No. 21 of 1998 as a national program in year 2007. Under this programme, the lands are surveyed demarcated, ensured ownership and issued a Title Certificate, free of charge. However, since its implementation in 2007 and up until 2017 it has not been able to register a significant number of lands despite the passing of 10 years since its implementation in 2007 and this research will analyse the short comings in this programme so as to find an effective solution so as to maximise the process of Title registration of lands in order to guarantee safeguards for private land owners through the process of title registration.

## II. LITERATURE REVIEW

Literature suggests the adoption of the titling system over the present deed system as crucial in order for a country to develop. Most experts would agree on the fact that some type of land registration system is a necessary element of a developed market economy. (Larsson, G. 1991). The ‘Torrens system’, named after Sir Robert Torrens and initially introduced in the year 1858 in South Australia, is one of the most widely known system of registration of title (Willoughby and Wilkinson, 1995). Land tenure security in itself is not sufficient for the full protection of the rights of an owner to a land, and land title security too should be afforded to a land owner to ensure maximum security to his or her land. (Michael Roth et al., 1989). With the existing legal pluralism in Sri Lanka along with other factors such as unclear boundaries to separate lands, ongoing land disputes, it is understood that resorting to a proper land registration procedure is the only means available to put an end to the issues relating to land tenure. (Perera, P. 2011: 92). However, despite spending 5 million US Dollars under the World Bank Funds for the “Sri Lanka Land Titling and related services project” (2002-2004) as per the evaluation made under the Implementation Completion and Result Report (ICRP Report) 2007, the land titling project was deemed unsatisfactory.

## III. METHODOLOGY

For the purpose of this research the administrative and the legal set up of the registration of lands (deed registration and title registration) were analysed to identify the short

comings in both systems. Primary data have been collected through face to face and over the phone interviews held with officials in the in the Bim Saviya programme to obtain current information regarding the implementation of the Bim Saviya programme. Practical limitations to the collection of primary data were faced as a result of the busy schedules of said government officials and unavailability of data in the required form. Secondary data was obtained through various journal articles, reports and literature with regard to the implementation of title registration in Sri Lanka and other countries.

## IV. REGISTRATION OF LANDS UNDER THE DEED REGISTRATION SYSTEM

The system of registration of documents was introduced to Sri Lanka in 1863 by the by the Land Registration Ordinance No 08 of 1863. Independent to this there was a start-up for the registration of title in 1877 by the Registration of Titles to Land Ordinance no 05 of 1877 as a trial in areas such as Wellawatte, Kirulapana and Dehiwala, the plan was to continue the registration of title via this ordinance to the rest of the island, however this was not possible as this process is very costly.

The present system of land registration in Sri Lanka, is based on the “registration of deeds” as per the Registration of Documents Ordinance of 1927 along with the Prevention of fraud Ordinance 1980 and Notary Ordinance of Sri Lanka. In this system it is the deed, which is registered. A deed is a record of a particular transaction between parties and this serves as evidence of this specific agreement. Therefore “registration of deeds” is a system for registering legal documents and it is not a system of registering title to land. Usually in a deed registration system, recording a deed does not automatically guarantee the relevant rights with regard to land. A deed in itself does not act as sufficient evidence as to who owns the land; it only records an isolated transaction.

The collection of such individual records of land transactions in a series, thus forming a chain of records forms the title. Transactions in land are as a result are very expensive and time consuming because it is essential to establish the full historical record of all transactions to establish the legality of a transfer and requires individual copies of evidence going back decades of years.

In the deed registration process the accuracy of the contents of the document registered is not investigated by the registering authority and as a result no guarantee is given to the contents of the deed such as the ownership of land, neither the boundaries nor the extent of the land is stated by the Registrar. In certain extreme situations, there can even be two or more deeds registered for one particular land and also there can be a deed registered for a land that is not even in existence. Anything in between these two extreme situations is possible in the deed registration system.

## V. REGISTRATION OF LANDS UNDER THE TITLE REGISTRATION SYSTEM

The shortcomings in the deed registration system paved the way to the Title Registration Act No. 21 of 1998. As observed by the reports of the Land Commissions held in 1955, and 1985, which recommended a modernized procedure for the registration of lands thus paved the way to implement the Title Registration Programme. The objective of this Title Registration System is to establish a complete database on the land resource of the country, and the proper land management. The project was commenced under the World Bank funds as a “Learning and Innovation Project” titled as the “Sri Lanka Land Titling and related services project” with the support of the Land Settlement Department, Survey Department, and Registrar General’s Department, which was implemented successfully until December 2006.

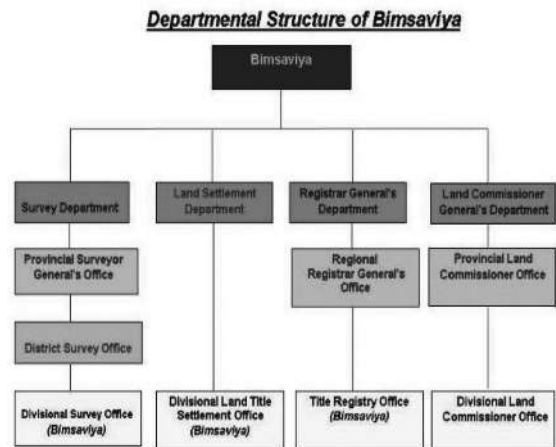
Presently this programme is implementing under local funds namely ‘Bim Saviya’ since 2007.

## VI. THE BIM SAVIYA PROGRAMME

“Bim Saviya” a program that is implemented under the provisions of Registration of Title Act No. 21 of 1998 as a national program in year 2007. The objectives of this programme are as follows,

- Introduce title registration instead of deed registration practised currently
- Settle or make arrangements to settle the ownership of the lands which are currently unsettled
- Establish a Digital System for Land Information.

Four governmental departments under the Ministry of lands and Ministry of Public administration work alongside Bim Saviya in order to survey, demarcate, ensure ownership and issue title certificate to the respective owner. (Figure 1.1) (Source Bim Saviya 2017)



**Figure 1.1**  
**Source: Bim Saviya (2017)**

Further this programme provides for online registration and online access to relevant land registration, it further organizes relevant awareness programs with regard to land registration. The Bim Saviya website provides a detailed procedure as to how the title to land is provided via this program but so as to summarise this process, the Bim Saviya Programmes is ensured with the task to,

- Make the public aware of the land titling procedure
  - Survey land parcels and prepare the cadastral map
  - Investigate and determine the title
  - Register the title and issue title certificate
- (Source Bim Saviya, 2017)

## VII. ANALYSIS OF THE PROGRESS OF BIM SAVIYA PROGRAMME AND ITS ISSUES

After the enactment of the Title Registration Act, the Sri Lanka “Land Titling and related services project” funded by the world bank (2002-2004) assisted in the

commencement of the registration of lands in Sri Lanka, and thereafter ever since its implementation in 2007, the “Bim Saviya” programme funded locally was bestowed with the responsibility for the registration of lands. However, from the year 2002 -2004 and from 2007- 2016 both these programmes together have only been able to only register 539,359 land parcels (including state lands) as opposed to the 12 million land parcels present throughout the country (Source: Bim Saviya Head Office) and this programme has been implemented in the relevant divisional secretariats of Homagama, Dehiwala, Moratuwa, Kesbewa, Ratmalana, Minuwangoda, Ja Ela, Dompe, Mahara, Katana, Wattala, Biyagama, Gampaha, Attanagalla, Mirigama, Kalutara, Panadura, Horana, Udapalatha, Udunuwara, Harispattuwa, Yatinuwara, Gangavatakorallaya, Dambulla, Pallepola, Kotmale, Nuwara Eliya, Galle, Hikkaduwa, Kadawatsathara, Matara, Weligama, Thihagoda, Beliatta, Lunugamwehera, Tissamaharama, Hambantota, Ridigama, Pannala, Malawapitiya, Kurunegala, Wariyapola, Kegalle, Warakapola, Wennappuwa, Puttalam, Anuradhapura, Thalawa, Rajanganaya, Nagenahira Nuwara palatha, Madirigiriya, Hingurakgoda, Lankapura, Ridimaliyadda Mahiyanganaya, Moneragala, Ratnapura, Balangoda, Ayagama, Kuruwita Nivithigala, Weligepola, Godakawela, Nallur, Karachi, Kilinochchi, Musali, Vavuniya North, Vavuniya South, Vakara, Manmunai North, Trincomalee, Kanthale, Ampara so far.

An analysis of the data clarifies that the amount of lands has been registered within the period from 2002-2016 is rather negligible (bearing in mind this was the number of land parcels registered and not the number of land titles issued)

compared to the total number of land parcels present and that this program is not showing any progress because at the rate at which the programme is registering lands it will take over 300 years to register all lands in Sri Lanka.

The main issues identified by the surveyor general’s department was the lack of understanding and knowledge of citizens with regard to the land titling procedure. The lack of employees who are knowledgeable as to the whole process of title registration. Lack of government funds to support this programme and lack of proper machinery to survey the lands to be registered.

Along with the aforementioned issues the overwhelming number of Governmental institutions involved in the procedure as displayed in figure 1.1 can be identified as one of the reasons for the long period of time taken for the

completion of the project. In countries such as Thailand only one institution which is the “Department of Lands” acts as the implementing agency of land titling and this leads to the smooth functioning of such procedure as only one governmental department is involved, therefore the presence of many governmental institutions involved in the process of title registration in Sri Lanka can be seen as a drawback to the effective implementation of this programme.

## VIII. RECOMMENDATIONS

The Bim Saviya programme was also entrusted with the task of providing awareness programs and workshops to citizens in order to educate them as to the land titling procedure, (Bim Saviya, 2017) however even though such workshops and programmes were organized by the Bim Saviya Programme in the past, that is not the case at present and as it was brought to light in the series of interviews held with the officials of the Bim Saviya Programme, one of the key reasons why this project is lagging behind is due to the lack of knowledge and awareness as to this program. Therefore, both the public and the employees working under this programme should be educated as to the process of land titling in order to make this program more effective. As only then will the public be able to understand the importance of this procedure and give its fullest cooperation in the process of titling of lands. Hosting awareness and educational programmes with regard to land titling is the most cost effective procedure that can be adapted in order to maximise the efficiency of the land Titling process with the limited number of funds entrusted for this process.

## IX. CONCLUSION

In conclusion it can be stated that considering the value given to land at present and its importance to a developing country like Sri Lanka, the issues with regard to the land titling programme and its implementation is an essential factor to consider in order to advance the development of a developing country. However, the present system of land titling in Sri Lanka is not very effective when considering its progress for the last 15 years ever since the Sri Lanka Land Titling and related services project in 2002. Having a proper land titling system would give rise to a greater number of foreign direct investments, lesser number of land disputes, it reduces the cost of dealing with land, it makes land records much simpler and protects a bona fide purchaser in a case of fraudulent dealing. These are few

of the advantages which a proper title land registration system is able to secure. With the existence of many personal laws in the country, the best way to enforce one's rights to a land is by obtaining a title certificate to such land and this title certificate can only be obtained if the existing title registration system in the country is effective in its implementation. Title registration is a more simplified and effective procedure as opposed to the deed registration system, resorting to the title registration system is more beneficial to a country's development in the long run.

#### ACKNOWLEDGMENT

Sri Lanka being a developing country does not have a proper system to contain all relevant documentation with regard to the registration of land and issuing of titles available to the public. I would like to sincerely thank Ms. Piumi Attygalle, Assistant Secretary of the Bim Saviya Programme and Mr. R. K. Sarath, Senior Superintendent of Service of the Bim Saviya Programme for providing me with the relevant information of the present implementation status of the Bim Saviya Programme despite the hardships they had to go through to find such information. Further I would like to thank my parents for their tremendous support in doing this research.

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- Ms. W. A. S. M. Fernando is an undergraduate at General Sir John Kotelawala Defence University. She is currently in the third year of her LLB degree programme

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*Management,  
Social Sciences  
and Humanities*

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“Changing dynamics in Management Social  
Sciences and Humanities”

## SESSION SUMMARY

### Oral Presentation (Parallel Session I)

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The Oral Presentation Session (Parallel Session I) under the theme of “Changing Dynamics in Green Practices” was chaired by Prof. Weerakoon Banda, who is attached to University of Sri Jayawardenapura, Sri Lanka. The speakers of the session were Ms. Ama H Wickramarachchi, Ms. Sakuni YD Wanniarachchi, Ms. RMNC Swarnapali and Ms. PBWS Malshani.

The first speaker, Ms. Ama H Wickramarachchi, attached to the Cardiff Metropolitan University, ICBT campus, delivered her presentation on the topic, “Identifying the Impact of Banking Products to Green Banking Initiatives: Case Study for a State Bank”. In her presentation she discussed on identifying the impact of banking products of the selected bank towards implementing green banking initiatives, identify the most important banking products of the bank in implementing green banking and analyse the most effective means of making customers aware of green banking initiatives of the bank. As the findings, she has identified that e-accounts create the highest impact (47.7%) on implementing green initiatives across the bank.

The second speaker was Ms. Sakuni YD Wanniarachchi, an undergraduate from the Faculty of Management, Social Sciences and Humanities at General Sir John Kotelawala Defence University, delivered her presentation on the topic, “Analysis of the impact of Green Practices on the performance of Large Scale Apparel Industry of Sri Lanka”. Her major finding showed that reduction of water usage, reduction of energy usage, reduction of carbon foot print and reduction of the environmental impact all have strong

positive relationships with the organizational performance of the large scale apparel manufacturing industry. Also she revealed that many of the large scale apparel manufacturers have already started recycling suitable products such as plastics by partnering with the relevant parties.

The third presenter, Ms RMNC Swarnapali who is affiliated to the School of Management, Huazhong University of Science and Technology, Wuhan, China, delivered her presentation on “Determinants of Corporate Sustainability Reporting: Empirical Evidence from Sri Lankan Listed Companies”.

According to her presentation she indicated that industry, leadership duality and directors’ shareholdings are not significantly associated with sustainability reporting. Further she stated that profitability, firm size, leverage, firm growth and firm age are significant firm-specific determinants of corporate sustainability disclosure while board size, board independence, female directorship and board ethnicity are significant board-specific characteristics of sustainability disclosure of firms.

The fourth and the final speaker was Ms. PBWS Malshani from Faculty of Management, Social Sciences and Humanities, General Sir John Kotelawala Defence University. She presented on “Disaster Mitigation Strategies in Urban Development: With Special Reference to Kaduwela Area”. The study had found that structural flood mitigation and non-structural flood mitigation strategies influence the effectiveness of Flood mitigation strategies in urban development.



## Oral Presentation (Parallel Session II)

The Oral Presentation Session (Parallel Session II) under the theme of “Changing Dynamics in Manufacturing Practices” was chaired by Dr. R.A.Rathnasiri, who is the Senior Lecturer, Dean/Faculty of Business Studies and Finance, Wayamba University of Sri Lanka. The speakers of the session were Ms. WDH De Mel, Mr.DGND Jayarathne, Mr. RASA Perera and Mr. HN Adipola.

The first speaker, Ms. WDH De Mel, a graduate of University of Colombo and is currently attached to General Sir John Kotelawala Defence University, delivered her presentation on the topic, “The Effects of Corporate Governance on Capital Structure: A Study of Listed Manufacturing Companies in Sri Lanka”. In her presentation she attempted highlighting the need of identifying the effects of corporate governance on capital structure in firms listed in the manufacturing sector in Sri Lanka. As the findings, she has revealed that proportion of non-executive directors, CEO duality and director ownership tend to have positive and significant relationship with capital structure while the association between board size and capital structure depicts negative, insignificant relationship.

The second speaker was Mr.DGND Jayarathne, delivered his presentation on the topic, “Cost Optimization of Distribution network in Coca Cola Beverages Sri Lanka Limited”.

The researcher has developed a mathematical model to optimize the cost of outbound distribution, using

Integer Linear Programming. The researcher stressed the importance of using a system in the distribution network is by presenting a cost reduction of approximately 18%.

The third presenter, Mr. RASA Perera from National Institute of Business Management (NIBM) Kurunagala Regional center, delivered her presentation on “Determining the Statistical Process Control Limits for uncertified Sri Lanka Standard (SLS) Boxes of Matches in Sri Lankan Market”.

He has determined whether SLS Uncertified Boxes of matches are Really safety related to its production process using statistical quality control equations, statistical quality charts. The presenter highlighted that the boxes of matches which do not have SLS are unsafe due to the uncontrolled production process based on SLS.

The fourth and the final speaker was Mr. HN Adipola from CINEC Maritime Campus, Sri Lanka. He presented on “Analysis of Factors Affecting the Effectiveness of Indirect Procurement Process of Manufacturing Firms”. With the findings of the research,

According to the study the internal procurement procedures, operational characteristics of the procurement department, management of external factors and procedures with suppliers found to be the most influential factors for indirect procurement process. Further the presenter stressed the necessity of organizations to focus more on these factors to improve on the effectiveness of indirect procurement processes which will in return help them to have smoother and more productive operations.

## Oral Presentation (Parallel Session III)

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The Oral Presentation Session (Parallel Session III) under the theme of “Changing Dynamics in Organizational Practices” was chaired by Prof. Milton Rajarathna, who is attached to University of Peradeniya, Sri Lanka. The speakers of the session were Ms. KH Malwenna, Mr. SL Lokuhitige, Ms. P Lankeshwara and Ms. T Henegama.

The first speaker, Ms. KH Malwenna, attached to General Sir John Kotelawala Defence University, delivered her presentation on the topic, “Impact of Human Resource Practices on Enterprise Performance in Small and Medium-Sized Enterprises of Sri Lanka”. In her presentation she discussed on addressing the linkage between Human Resource Management practices and enterprise performance, and to identify the impact of HR practices on enterprise performance in contemporary SMEs in Sri Lanka. As the findings, she stated that HRM practices are positively related to better enterprise performance.

The second speaker was Mr. SL Lokuhitige, an undergraduate from the Faculty of Management and Social Sciences – CINEC Campus, delivered his presentation on the topic, “A study on the factors influencing the use of e-commerce by customers in Colombo with respect to B2C market”. His major findings showed that there is a highly positive opinion towards online purchasing and people do have the willingness towards it. Also he revealed that it was found that attitudinal factors have a profound effect while subjective norm and perceived behavioural

control shows a superficial effect on the online purchasing intention.

The third presenter, Ms P Lankeshwara who is affiliated to the Faculty of Management, Social Sciences and Humanities, General Sir John Kotelawala Defence University, delivered her presentation on “The impact of micro financial support on development of small and medium scale enterprises (SMEs) (With special reference to Anamaduwa Divisional Secretariat in Puttlam District)”. According to her presentation she indicated that financing of SMEs (credit facilities), development of management skills and marketing facilitation cause to increase the growth and development of SMEs and the development of management skills could be identified as the most crucial factor for predicting the growth and development of SMEs. Further she stated that satisfaction level of SMEs towards credit facilities and the development of management skills and marketing facilitation were recorded at moderate levels.

The fourth and the final speaker was Ms. T Henegama affiliated to the Navy General Hospital, Colombo. She presented on “Study on Job Satisfaction and Absenteeism among Senior and Junior Sailors of Medical Branch in Sri Lanka Navy”. The study had found that 73% of the participants strongly agreed or agreed that their job helps them to learn lots of skills. 73% of the participants strongly agreed or agreed that this their job helps to improve experiences.

## Oral Presentation (Parallel Session IV)

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Prof. Saman Bandara chaired the fourth technical session of the Faculty of Management, Social Sciences and Humanities at the 10th International Research Conference on 04 August 2017 from 1500 hrs. to 1630hrs under the theme of 'Changing Dynamics in Logistics and transport. There were altogether three presenters who published their research findings.

GM Ranathunga presented a paper on 'Impact of different traffic movement on revenue of Bandaranaike International Airport'. It was a joint study with V Waidayasekera and R Mudunkotuwa. Here in this research, the monthly gross revenue of Bandaranaike International Airport had been modeled in association with monthly international aircrafts movement and monthly international passenger movements.

PMNP Wijerathne presented a paper on 'Developing an electronic accident reporting system to Sri Lankan apparel

industry'. This was a joint study with NHC Manjula. Researchers have developed an electronic accident reporting system and a mobile app for the Sri Lankan apparel industry. This system consisted of user friendly command buttons, easy to collect accident records, instantly notification facility and direct communication with industry. The mobile app consisted of facilities to manage even lower level employees in industry.

DR Ratnajeewa presented a paper on 'Determinants that affect the selection of a logistics service provider in the manufacturing industry with reference to Sri Lanka'. It was a joint study EAKB Ekanayaka. Asset related factor, qualitative factor, financial factor, specialization factor, risk and expense factor, evaluation factor, and billing flexibility were found to be the main factors affecting the selection of a logistics service provider by the manufacturers as per to this research.

## Oral Presentations Parallel Session II

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The Oral Presentation Session (Parallel Session II) under the theme of “Changing Dynamics in Critical Social Studies” was chaired by Rev Prof. W Wimalarathana, who is a Senior Lecturer at the Department of Economics, Faculty of Arts, University of Colombo. The speakers of the session were Mr. KAC Karunarathna, Ms. WAS Thilanka, and Mr. AMI Gunarathna.

The first speaker, Ms KAC Karunarathna has obtained Bachelor of Arts special degree in Psychology from university of Peradeniya and Mphil degree in Clinical Psychology from Faculty of Graduate Studies, University of Colombo. Currently she is employed as a Psychologist at Sri Lanka Navy. Her topic was “presentation and correlates of moral injury as

a response to past transgression”. In her research, she had qualitatively explored the presentation and the correlates of moral injury in a non-military prisoner sample, using a working model, postulated by Litz (2009). Even though shame and guilt are jointly expected to lead to social withdrawal according to the model, she hadn’t found the same in her findings.

The second speaker, WAS Thilanka, has obtained her BA degree in Sociology from University of Colombo and is reading for masters in the same university. Currently she is working as a junior lecturer at the department of Sociology of University of Colombo. Her topic was “Exclusion within Exclusion: Gender Stereotyping of Vocational Training in Prison”. Her main objective was to examine the gender differences in implementing vocational training programmes in prison. After narratively analyzing the

data, it was found that prison overcrowding has made it hard to deliver a quality vocational training and the fact that gender neutral access to training is limited. And also, the policy makers, department of prison and the society have also been provided recommendations through her study.

The third speaker, AMI Gunarathna, who is a senior lecturer in Economics in Sabaragamuwa University, has obtained his Basic and master’s degrees from the University of Colombo. He presented on the topic “The Factors that affect the demand for Private University Education in Sri Lanka”. The research examined the socio-economic factors that could affect the demand for private university education of undergraduates in South Asian Institute of Information Technology. Through the research the researcher has found gender, parents’ occupation, parents’ education level, ethnicity, A/L attempts...etc as the key factors which affect the demand of private university degree programmes.

At the end, there was a 16-minute session for the questions and answers in which an intellectual conversation was built. Dr. Jayewardena, the Dean of the Faculty of Management, Social Sciences and Humanities of KDU, asked questions from each speaker where as Dr. Liyanage, representing the judge panel threw questions while advising the 1st and the 3rd speaker to think about ethical considerations in their respective work. Finally, the session was concluded with the summing up observations of the chair. He advised the researchers to think about their research gap, titles (as the titles are not appealing according to the chair), suggestions and improvement. He further congratulated the researchers on their future endeavours.

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*Plenary  
Speeches*

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# GLOBAL PRODUCTION DYNAMICS AND RISE OF ASIA

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Asia has become the fastest-growing region in the world. Yet it seems that many have not seen it as an outcome of the global production dynamism associated with long-term business cycles. In the year 1817, it was about the economy of England that economists were fascinated about. In 1917, it was all about the US economy, while after 100 years – today in 2017, it is about Asia. Growth of Asia is an outcome of a divergent conditions and events

in the global economy which ultimately converged and produced impressive performance in trade, investment, and economic growth. Even for Sri Lanka, it is the biggest opportunity that it ever had throughout its post independent history. Whether we pass through or pass by this opportunity is absolutely in the hand of Sri Lanka itself.

# CHANGING DYNAMICS IN BUSINESS ENVIRONMENT

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Civilisations throughout history have depended on individual initiatives organised as businesses to create wealth and generate prosperity to members. However, like any other natural phenomenon, businesses are also subject to evolution and constant change. These changes have facilitated them to survive, grow and prosper. In the modern world, these changes are taking place at an unprecedented rate requiring businesses as living organisms to successfully wade through them. Such changes in turn require those who run businesses as well as those who receive their services too to change. Two dynamics have changed substantially in the last few decades or so creating a completely new business environment. One is the technological dynamic represented by advancements in information and communication technology (ICT) generating a paradigm shift in how businesses do their business. The other is the social dynamic which requires businesses to function responsibly and with accountability to meet the social goals. The first has forced the businesses to think anew, strategise for an unknown future world and be a partner of the change rather than remaining a victim. It requires all those who run businesses to de-educate themselves and re-educate them with new knowledge. Since the existing

technology, business practices and investments are subject to continuous diminishing returns, with fast changing ICT, businesses are to reach the saturated point fairly quickly pushing them along a downward growth spiral. In these circumstances, the challenge is to assume a new identity, supported by new technology, making it possible for them to make a series of 'quantum leaps'. In the social dynamic, the community expects from businesses the same high service and governance standards as they expect from public sector institutions. The new business world is now characterised by society's demand for good governance, accountability, full disclosure and openness. In this new world, the old corporate social responsibility (CSR) behind which businesses had been taking cover for some time have become irrelevant. If they fail in their social dynamic responsibilities (SDR), they are constantly subject to public protests and agitations making it difficult for them to survive in a competitive market, on the one hand, and public interest litigations which place legal impediments for them to continue as businesses, on the other. A successful business is one which is conscious of both these dynamics and ready to adopt suitable strategies to derive maximum benefits for themselves.

# STRATEGIC VALUE OF THE BELT AND ROAD INITIATIVE FROM THE MARITIME TRANSPORTATION AND LOGISTICS

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The “Silk Road Economic Belt and the 21st-Century Maritime Silk Road” (collectively known as One Belt One Road: OBOR) has been initiated by the Chinese government in 2013. The OBOR is increasingly becoming a focal point for socio-economic- political interests because of its likely impact on land and sea transport and maritime logistics. The geographic coverage of the OBOR indicates an approach to enhance wider regional economic development along major economic and maritime corridors that will connect China with strategic trade hubs and industrial clusters. The corridor developments in the OBOR face numerous challenges in developing logistics and container port infrastructure to reduce logistics costs. For example, China-Pakistan Economic Corridor (CPEC), Bangladesh- China-India-Myanmar (BCIM), Economic Corridor Corridors in Greater Mekong Sub-Region

Economic Cooperation, and Lanzhou-Kathmandu South Asia Freight Rail may affect maritime transportation and logistics system directly and indirectly. Therefore, we need to investigate a new hub-and-spoke system in the Indian Ocean. The aim of this presentation is three-fold: first, to provide an overview of the OBOR focusing on its key elements, such as corridors, city clustering, dry ports, infrastructure, zone and area development, in association with a visual approach; second, to investigate the expected impacts and implications of the BRI on maritime transportation and logistics; and third, to highlight maritime strategic value of OBOR in tandem with policy suggestion from the viewpoint of Sri Lanka.

**Keywords** - One Belt One Road, Hub-and-spoke, Container port, Economic Corridor, Indian Ocean, Sri Lanka.



# CHANGING DYNAMICS IN LANGUAGE AND COMMUNICATION ENGLISH CULTURAL WESTOXICATION AND CONFUSED NATIONS

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English language and its culture is not merely a representation of the colonial masters' language in today's context. They are synonymous with capitalism, westernization and materialism. As opposed to communal and duty-bound native cultures, individualistic, rights and freedom-based western cultures appeal to the younger generations. This appeal is further strengthened by the 'developed' nature of western societies in the face of a never-ending struggle 'to develop' the third world. English language, as an unmistakable carrier of the aforesaid westoxication, influences and shapes the cultures of the developing nations. This paper examines the dichotomous nature of the functioning of English language and English culture in the context of the mother tongues and local

cultures in Sri Lanka in its various facets of communication and attempts to draw parallels with her neighbouring countries such as India and Pakistan. Communicating in English is a sure manifestation of a kinship to the culture it represents and is desired by many learners of it. At the same time, the lack of confidence to communicate in it, mainly in the spoken form, is a strong detriment that stems from attitudes prevalent in the Sri Lankan society. With failed attempts to communicate in it, mostly through speaking, the younger generation resorts to various other means of representing an Anglophone culture, which results in either an ignorant or confused cultural identity.

**Keywords** - confidence, confusion, English culture, failed attempts, westoxication

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*Technical  
Sessions*

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(ORAL AND POSTER PRESENTATIONS)

# THE GAZE, IMAGE, AND (HI)STORIES: A CRITICAL REVIEW OF THE REPRESENTATION OF THE RAPE AND MURDER OF VITHYA SIVALOGANATHAN

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**Abstract** - Media construction, representation and discourse of rape have a considerable power in shaping public understanding and knowledge of rape, and the use of images has a significant impact on this as a “photograph immediately grabs the viewer’s attention and triggers profoundly personal responses—emotional, paradoxical and not always rational” (Roberts, 2011). These dynamics are at work in Gossip Lanka news articles on Vithya Sivaloganathan’s rape and murder which occurred in May, 2015, and the present study has analysed the manner/s in which the rape and murder of Vithya Sivaloganathan is constructed, which also enables multiple discourses, ways of seeing (the gaze) and understanding rape, violence and murder along with their re-presentations (the image and (hi)stories), in order to examine the ways in which rape is constructed with the use of images, and identify how constructions of rape enable ways of seeing and understanding rape. The study revealed that the images were often used to guide the audience’s perspective in a particular way desired or pre-designed by media, and at times the accuracy of the images used were also questionable. Therefore, the need for a more responsible, non-sensationalist type of representation of serious issues is identified. However, it was also identified that the audience may have the potential of seeing beyond the media manipulation.

**Keywords** - Representation of Rape, Vithya Sivaloganathan, Sri Lanka, Gossip Lanka

## I. INTRODUCTION

When considering the role of media reporting vis-à-vis the concept of rape, it is obvious that media construction, representation and discourse of rape have a considerable power in shaping public understanding and knowledge of rape. More than the written word, images are capable of sending powerful messages as a “photograph immediately grabs the viewer’s attention and triggers profoundly personal responses—emotional, paradoxical and not always rational” (Roberts, 2011). This study aims to examine how the rape and murder of Vithya Sivaloganathan is visually depicted on a selected online news platform, namely, Gossip Lanka, and the implications of such representation. According to Foucauldian understanding of discourse it is suggested that discourse ‘constructs the topic’ (Hall, 1997). If so, the discourse surrounding Vithya Sivaloganathan’s rape and murder may have an influence on the ways in which the audience read, view, understand/ form knowledge about the issue of rape and murder. Therefore, it would be of interest to explore how the rape and murder of Vithya Sivaloganathan is constructed, which, in turn, enables multiple discourses, ways of seeing (the gaze) and understanding rape, violence and murder along with their re-presentations (the image and (hi)stories). Hence, the objectives of this research are to examine the ways in which rape is constructed with the use of images, and identify how constructions of rape enable ways of seeing and understanding rape.

## II. METHODOLOGY

The research intends to analyse the images on Gossip Lanka news articles about Vithya Sivaloganathan's rape and murder which occurred in the year 2015. The images vis-à-vis the content in five articles which were published from 15th May to 24th May 2015 under the heading "Brutal Murder of Jaffna Student" will be analysed.

The primary analysis of this critical review is based on the first five news updates of Vithya's rape and murder on Gossip Lanka, dated 15th, 18th, 19th, 22nd and 24th May, 2015. Gossip Lanka news articles were chosen for the analysis since this is a popular source of news accessed by a majority of the general public of Sri Lanka (Alexa ratings, 2016). Since the articles are published in Sinhala and English both it reaches a wider audience (though mostly literate only in Sinhala) than, for instance, Colombo Telegraph or Groundviews. Hence it is important to analyse how rape is constructed and represented in news items which are consumed by the masses. In addition to the five articles, references would be made to other online articles on the incident and theoretical texts which bear relevance to the points discussed.

The primary method of analysis is a close reading and content analysis of the texts with particular focus on the images in the articles, and the critical review focuses on positions of seeing (the gaze), and modes of representation and construction of rape (the image and (hi)stories). The analysis has extensively drawn from Laura Mulvey's theories of perverse spectatorship and the gaze, and Foucauldian understandings of discourse. Review of literature has also been woven into the analysis itself in order to present more profound and nuanced insights on rape and its representations.

## III. ANALYSIS

As stated by Sophia E. Shaw, Ellen Nye, Joanna Jamel & Heather D. Flowe, "the print media are a key disseminator of knowledge. With a large percentage of the population solely dependent on the media for facts, media reports can influence public opinion at large, and even impact criminal case outcomes" (2009). Therefore, analysing the significance of news reports and images can be considered crucial in gauging the impact made by media depictions on viewers.

According to one researcher, "the notion that a photographic image provides a straight reflection of the "reality" of people, a scene, a landscape, etc. assumes that by "simply looking", we "know" the image as reality"

(Roberts, 2011). Hence it can be argued that the image has the power to construct particular realities.

In such a context media representations of rape has significant potential in constructing rape, and influencing the ways in which the public understands rape. Ambika Satkunanathan in her article *The rape and murder of Vidya: Do women really matter in Sri Lanka?*, comments that the photograph of Vithya's body has a symbolic value, and that it

"...reminds us, hopefully and inter alia, of the many more like Vidya in Sri Lanka, and that debates around the aesthetics and ethics of journalism aside, this horrible business of rape must end" (Satkunanathan, 2015).

On the other hand, reporting of rape can be problematic. Brownmiller's study states that reporting of rape is 'more complex than simple, factual reporting' (Brownmiller, p.337, 1975). She also points out that media tends to report only 'selected rape', which will be 'enhanced by certain elements of glamour and aided by the use of stimulating adjectives, judiciously written in' (Brownmiller, p.337, 1975).

As indicated by the literature, an in depth understanding of media representation of rape and its implications can be gained through analysing images in news articles. Therefore, the present study will examine how the rape of Vithya Sivaloganathan is visually represented in Gossip Lanka news articles, and the implications of such representation in influencing rape discourse, and ways of seeing and understanding rape.

Vithya Sivaloganathan's rape and murder which occurred on 13th May, 2015 became an event much discussed in Sri Lanka. Despite the delay in making it to the newspaper headlines, the news of this brutal rape and murder was given much prominence and publicity in media once it attracted the attention of media following the hartal in Jaffna demanding justice.

The news of Vithya Sivaloganathan's rape and murder did not feature Gossip Lanka news till 15th May, 2015 which shows the amount of importance attached to the news prior to the protests held in Jaffna on that day, and the former president Mahinda Rajapaksa's dubbing the protests as a sign of resurgence of Tamil terrorism.

Was this because rape has become commonplace and media has other, more important news to cover? Or is it because what happens in the Northern peninsula does not affect the rest of the country unless there is an undercurrent or implication of terrorism? However, media culture awaits rupture and the moment they spot a newsworthy rupture they generally tend to harp on it. In

this context it might appear that the politicized version of the rape and murder was what gave the incident its news value, i.e. marketability.

The first article, published on 15th May 2015, briefs the readers of the rape and murder with a collage containing a photograph of Vithya, and a few of the protestants, along with a caption highlighting the gender and status of the victim. The second article on Gossip Lanka titled Elder and younger brother get together and commit rape on Advanced Level student ....and after killing her, has hid her in jungle near the home, however, focuses more on sensationalizing the rape highlighting the facts that this is a gang rape, and the victim is a schoolgirl.

Vithya's images which accompanied the articles on her rape and murder are an important aspect for analysis. As Mary Anne Layden claims, people

"...learn better using images than words, because images carry more information in a more compact form. A split-second look at an image can convey more information than a split-second look at words. Words are often perceived as opinions while images are often perceived as events or facts. We argue in our head against words or opinions, but much less often against events or facts, particularly images" (n.d. p.1).

The first photograph accompanying the article is a collage of four pictures; a crime scene of a rape (not Vidya's), Vidya in school uniform, grief stricken mother at the funeral and a student protest.



**Image A: Photo montage in Gossip Lanka Article dated 18th May, 2015**

What generates interest here is the first frame of these four; the image of a female corpse. According to Simone de Beauvoir (1956), and Judith Butler (1986) 'the body is not a lifeless fact of existence, but a mode of becoming' (p. 38), and it can be argued that the process of becoming is closely tied up with ascribing meaning, knowledge and interpretation to it. In this situation though it is obvious that this is not the body of Vithya, and may not even be the

corpse of a rape victim, the body is ascribed the meaning of a body subjected to rape and murder. A closer look at the implications of this image reveals that it is an attempt to cater to the so-called tropes of rape news reporting. Inserting a picture of a female corpse grabs the attention of the viewers and contributes in representing the main points of the article in a single collage; beautiful Tamil student, raped and murdered, funeral and protests held. The construction of the image thus guides the gaze of the readers. It seems to position the viewer outside the picture while media manipulates the way s/he grasps the news. This may damage the reliability of the news report, but adds to the sensational element of the news where news providers are concerned more with attracting an audience than maintaining accuracy.

In her seminal article Visual Pleasure and Narrative Cinema, Laura Mulvey (1999) analyses the male gaze and representation of the female as the object of the gaze. She further explains how the woman on screen is simultaneously subjected to the gaze of the males on screen and the spectators outside. Her central argument is that women are subjected to multiple gazes and the spectator is encouraged to identify himself with the male protagonist on screen, 'his screen surrogate' (p. 338). By extending this argument, the present analysis finds a similar operation in the way the images are presented in Gossip Lanka articles on Vithya's rape.

This projection invites gaze of the audience, and while gazing on the victim, the audience is encouraged to identify themselves not with the victim, but with the camera. To elaborate, the camera gazes on the victim and the audience follows the camera's gaze. In doing so, the audience identifies with the camera and the eye that seeks the truth, and hardly with the victim.

As opposed to the gaze of Vithya in the school uniform looking at the camera or at the readers, the third image of her mother at her funeral offers a sharp contrast. There the gaze is directed at the coffin. The public is primarily invited to behold the grieving mother, but the attempts of photographing or videoing also seen in the picture (the person on the left of the mother) shows how the demarcation between the private and the public has become blurred, i.e. the personal grief of a mother and the tragic death of a young girl have become 'news' for public consumption.

The third news update dated 19th May presents the news in a novel angle of interest by introducing the 'Swiss national' who has 'videoed' the rape, destruction of the houses of the perpetrators by angry mobs and another

hartal. The anonymous ‘white-skinned national coming from Switzerland’ (Brutal Murder of Jaffna Student, 2015) is used to raise the curiosity of the readers, but even in the fourth update the identity of this individual has not been revealed. The image accompanying the article is another collage.



**Image B: Photo montage in Gossip Lanka Article dated 19th May, 2015**

This, once again, attempts to summarize the focal points of the storyline of the article, as it highlights the camera and the arrest of the victims. The montage once again cleverly directs the audience’s gaze, and even before reading the content the audience is given a blueprint that may frame their mindset.

The most detailed account of the incident is given in the fourth update dated 22nd May. It grabs the readers’ attention with the captions Police who looked aside when said girl was missing... had said, “may have eloped”-Body found by brother who went in search alone -A female Deputy Minister alleged to have influenced Swiss national to be released!-True story of Jaffna student covered up by Colombo media.

The article sums up the inefficiency of the police, political involvement hindering justice, and concealment of ‘truth’ from the public. The fragmented title itself provides a kaleidoscopic view of the incident. The active involvement of the police hitherto indicated in Gossip Lanka articles on the incident is falsified by this update where it is revealed that the police has been negligent, and even the discovery of the corpse was done by the victim’s brother. The way in which the blame is directed at ‘Colombo media’ for concealing the ‘true’ story of Vithya Sivaloganathan is rather ironic. Gossip Lanka too is part of the body of ‘Colombo media’, and shares the blame as well. However, it seems to be overlooked in the project of making the news more appealing to the public. This is then followed by a lengthy, detailed account of the rape as the “true story as reported now is as follows”; which problematizes this ‘truth’, i.e. does this mean that their version of truth is also temporal and subject to change?

The construction of the incident involved a number of competing, contradictory narratives. A case in point is Gossip Lanka articles’ revelation of the reasons for this crime. According to the fourth update,

“The mother of Vithya, Sivaloganathan Saraswathy had served under a doctor in his house and one day on seeing 3 robbers who had tried to rob the house she had given evidence at the identification parade in courts of those 3 persons living in this area. When the police questioned her as to whom she suspects in connection with the murder of Vithya, what she had told the police was that because of the incident of identifying these robbers they had not been on good terms with her after that and that they could be connected to this murder. Accordingly when the police interrogated on suspicion the 3 brothers of the same family down that lane after a few days after this murder, they confessed before long that they were involved in this incident”, (Brutal Murder of Jaffna Student, 2015)

This fact is also mentioned in the fifth update dated 24th May, as part of the confession of the rapists. However in an interview of Sivaloganathan Saraswathie, Vithya’s mother, published in Ceylon Today, she denies this version saying, “I have never given any evidence against them. It is a story fabricated by the killers. They wanted to rape and kill my pretty daughter” (Sivaloganathan, 2015).

Constructing the ‘truth’ of this rape and murder in media thus becomes challenging in the face of contradictory narratives, and rather than giving a balanced account of the incident the media culture of the country may tempt media to pick the narrative which triggers public interest most as the dominant narrative. Hence the commercial underpinnings of representing, constructing and reporting rape appear to be the principal governing body. It can be argued that power of media representation is ultimately linked to commercial interests, which raises questions on media ethics.

The article dated 24th May includes a confession by the perpetrators at the courts, and it contains a detailed account of how they committed the crime. It highlights the tropes of rape such as violence, vengeance and total victimization of women, in other words a typical rape story. If we apply E. Diamond’s understanding of mimesis to this, it is evident that though repetition of the tropes and details of rape and reinforcing of violence attempt to create a mimesis of rape, it is possible for the viewers to unmake mimesis and read the power-plays or undercurrents used in promoting a certain reading (Diamond, 1997).

The pictures in the articles capture and project Vithya as a student, a young girl and a rape victim (see images A, D

and C in Appendix A). The image A represents Vithya as an ordinary school girl dressed in uniform, with the pottu on her forehead indicating her ethnic identity. The image on the left in image C shows her as an ordinary young woman with no indication of ethnic identity. One active protestant used this photograph on the left (cropped) as his profile picture before media gave publicity to the event, and some of his friends posted comments asking whether she was his girlfriend. This shows that when taken out of context, the image has less potential unless there is awareness on the side of the audience. The image D and the images on the right of image C, however, clearly represent Vithya as the victim. As Michel Foucault argued, an image or any other form of representation does not have meaning or cannot generate specific knowledge when taken out of its context (Foucault quoted in Hall, 1997). Thus it is evident that to grasp the meaning of these representations they need to be placed in the context of rape and murder. In this instance, media becomes the power which places the images in the context and guides the readers in their viewing or 'reading' of the image.

However, being part of a postmodern society, all readers do not view the images with the lenses provided by media. Eve Oishi's concept of the perverse spectator (2006) plays an active role in this instance where people openly condemned and objected the public circulation of Vithya's images. On the one hand these images give weight and truth effect to the story covered by the articles, and on the other they expose the victim to the readership and the society at large. The latter was viewed by many as a violation of the privacy of the victim.

Image D in particular generated controversy as these perverse spectators argued that subjecting her body to the gaze of the public is disrespectful and a violation of her privacy, leading to an ethical discourse, which resulted in removal of those pictures. So it is evident that discourse can be generated through representation.

Nevertheless this is not the only discourse springing from these images. The author of the post What happened in Jaffna should not stay in Jaffna in icaruswept, for instance, notes,

"I am not going to take this picture down, though I take no pleasure in posting it here. My purpose is to show you what the media deftly reduces to "a schoolgirl was raped". Understand that "rape" is not simply an occasional curse word or a Pornhub filter. This is the savage act that rape is – and by ignoring it, by refusing to see it, we paint over the horrifying ugliness that would otherwise churn our hearts" (Icaruswept, 2015).

The bound and gagged (according to the articles) corpse with arms and legs twisted in painful angles sends a strong message of the torture undergone by the victim, to be registered by the viewers, and the writer seems to call for a more practical and radical stance in terms of raising public awareness on how despicable an act rape is. S/he views censoring of such 'disturbing' images is a mere act of glossing over the brutality of rape. This may have a point because there are other forms of media (like pornographic videos of rape or forced sex) glorifying the act of rape, where rape is shown as a demonstration of power which more often than not is enjoyed by the victim and less traumatic (Check and Malamuth, 1985). Mary Anne Layden in her article Pornography and Violence: A New Look at Research, writes that such representations

"...give us permission to engage in a behavior we would like to engage in or are engaging in and tell us there is no need to stop, change, or reduce it...This "may be pornography's most insidious influence; namely, the acceptance of the attitudes (some obvious, some more subtle) expressed in pornography. Pornographic depictions of the sexuality of women and children distort the truth about desires of women and children, and legitimize men's sense of entitlement, and use of force, violence, and degrading acts by the male actors" (n.d. p. 2).

In such a context where media offers representations of rape as acceptable practice or behavior, there is a need for making the public see through the rape myth and become conscious of the brutality of rape. But this leaves the viewers with the question whether displaying the mutilated corpse of the rape victim is the most effective or the only way of raising public awareness.

At the same time detailed accounts and explicit images of rape incidents may sensationalize the act and lead to other similar incidents or reinforce gendered discourses or practice of identifying victimization of women and power of men over women. The chain of gang rapes following the Delhi rape in India and another gang rape and videoing of a girl following Vithya's rape in Sri Lanka could support this argument.

The publicizing of Vithya's photographs tends to monopolize the gaze and the attention of the viewers, turning her into an object bearing evidence to the story narrated in the article. This representation becomes problematic where the victim ends up as the 'spectacle', i.e. the victimized woman, especially in the absence or the lack of presence of the perpetrators. In the articles and images analyzed in the present study, the perpetrators are literally caught in the audience's peripheral view,

(see image B, Appendix A). According to one article, the perpetrators consist of “3 brothers of the same family living close to the location where the girl’s dead body was found and in addition there is also a white-skinned national coming from Switzerland living in this same area and another 5 persons” (Gossip Lanka, 17<sup>th</sup> May). Except their names and a few small photographs, they exist in relative seclusion. The images invite the spectator to gaze at the victim while shielding/ignoring the perpetrators, which further objectifies the victim. Her body, history and personality are looked at and analysed repeatedly, making a practice out of it. This sole focus on the victim favours none but the perpetrators since their identities are overshadowed, and their names and faces would be soon forgotten by the public so that in the event of getting lenient punishment or early release they would be able to integrate into ordinary life without much stigma attached to them. An aspect often overlooked by media, this leads to the victim’s embodiment of rape, violence and murder whereas it would be more effective if the perpetrators were made to embody those.

Ambika Satkunanathan in her article *The rape and murder of Vidya: Do women really matter in Sri Lanka?* comments on the blurred version of the image C, “In light of the debates, here and elsewhere, the original photo – though widely available online – is now blurred to a point of abstraction. It reminds us, hopefully and inter alia, of the many more like Vidya in Sri Lanka and that debates around the aesthetics and ethics of journalism aside, this horrible business of rape must end” (2015). The blurring then helps depersonalizing of the victim, and the moment it stops being ‘Vidya’ it ‘becomes’ a symbol of rape. This broadens the discussion by inviting us not to discuss ‘the rape’, but rape. As opposed to the discourse which project Vithya as a victim, this leads to a discourse (be it on justice, women’s rights, human rights, or anti-violence) constructing and representing Vithya as a symbol. At the same time this may reduce sensationalizing of the images of the rape victim, and focusing more on addressing and grappling with the issue of rape as a social problem. Such different discourses springing in the radius of the rape and murder of Vithya show “the transformations which they have effected” (Foucault, 1991, p. 60). Though in Vithya’s case the sensationalizing and using the images as tools of marketing news had already taken place before ethical discourse countered it, the varied discourses on it have resulted in changing people’s perspectives of construction and representation of rape as exemplified in the above discussion.

## IV. CONCLUSION

As mentioned earlier, the Foucauldian understanding of discourse suggests that discourse ‘constructs the topic’ (Hall, 1997). If so, the discourse surrounding Vithya Sivalaganathan’s rape and murder would construct the issue of rape for the readers, or in other words, it would shape the ways in which the audiences read, view, and understand/form knowledge about the issue of rape and murder. When considering the role of media reporting vis-à-vis this concept, it is obvious that media construction, representation and discourse on the issue of rape has a considerable power in shaping public understanding and knowledge; hence the need for a more responsible, non-sensationalist type of representation over such grave issues. However, the above discussion contained instances where a perverse audience would see beyond the representations and discourses generated and propelled by media, and maneuver counter discourses where necessary. Therefore it can be concluded that the rape and murder of Vithya Sivalaganathan enables multiple discourses, ways of seeing, and understanding rape, violence and murder.

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## Appendix A



**Image A: Photo montage in Gossip Lanka Article dated 18<sup>th</sup> May, 2015**



**Image B: Photo montage in Gossip Lanka Article dated 19<sup>th</sup> May, 2015**



**Image C: The images that originally accompanied Gossip Lanka article dated 22<sup>nd</sup> May.**



**Image D: The image on icaruswept which the author refuses to remove**

# THE CONTACT BETWEEN SINHALA AND ENGLISH ORTHOGRAPHY IN ONLINE TEXT MESSAGES

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**Abstract** - At present, using English characters to represent Sinhala words appears to be a common feature in online texting among Sinhala-English bilinguals. This study examines the contact between Sinhala and English orthography in online text messages in which Sinhala words are represented using English letters. Much research has been conducted on the contact between Sinhala and English, features and conventions of Internet language and language contact in digital Internet genres. However, no research has yet examined the contact between Sinhala and English orthography in digital Internet genres in an attempt to identify patterns arising in such linguistic phenomenon. The data for the study come from a corpus of online text messages sent via mobile messaging applications (hereafter apps) such as Facebook Messenger, WhatsApp and Viber collected from 20 undergraduates in the Faculty of Arts of the University of Colombo. The text messages were collected using the friend of a friend method. The study identifies four main patterns of representing Sinhala vowel sounds and two main patterns of representing Sinhala consonant sounds through English letters. The findings invoke a need to expand the conception of frequent copying showing a potential emergence of a new variety of Sinhala in which the orthographic system is a result of the contact between Sinhala and English orthography. The identified patterns also help develop more user-friendly online Sinhala-English transliteration software than the existing ones such as Google Input Tools, SinGlish Transliterated and SinGlish (Phonetic) Transliterated which are either unable to identify certain patterns of representing Sinhala vowel and consonant sounds through English characters or have their own transliteration schemes which the users have to

adopt. Thereby, these patterns challenge the conventional idea that no system of transliteration of a (more) phonetic language by an unphonetic one like English can be perfect.

**Keywords** - online texting, contact, English orthography, spoken Sinhala sounds

## I. INTRODUCTION

Based on a corpus of online text messages<sup>1</sup> sent via mobile messaging applications<sup>2</sup> such as Facebook Messenger, WhatsApp and Viber in which Sinhala words are represented using English characters, this study aims to examine the results of the contact<sup>3</sup> between Sinhala and English orthography in online text messages. It identifies patterns of representing spoken Sinhala vowel and consonant sounds<sup>4</sup> through English letters<sup>5</sup> in online texting since “electronic discourse is writing that very often reads as if it were being spoken – that is, as if the sender were writing talking” (Crystal, 2004, p. 25). Due to space constraints, the study will not focus on the identification of patterns of representing Sinhala vowel and consonant clusters through English characters.

Research has been conducted on “digital Internet genres” (Mendis, 2006, p. 125) focusing on features and conventions of Internet Language (See, for instance, Porter, 1996; Davis & Brewer, 1997; Baron, 2000; Crystal, 2004; Zitzen & Stein, 2004 etc.) and the contact between two languages in digital Internet communication (See, for instance, Su, 2006; van Gass, 2008; Devic, 2008; Huang, 2009; Temur & Vuruş, 2009; Themistocleous, 2010; Tagg & Seargeant, 2012; Rafi, 2013 etc.). The contact between

Sinhala and English has also been researched in the study of Ceylon English, Lankan English and/or Sri Lankan English (SLE) (See, for instance, Passé, 1948, 1950, 1955; Halverson, 1966; Chithra Fernando, 1977; Siromi Fernando, n.d., 1985, 2003, 2008a, 2008b, 2011/2012; Gunasekara, 2000, 2008; Herat, 2006; Meyler, 2007; Siromi Fernando, Gunasekera & Parakrama, 2010 etc.). Moreover, based on Short Message Service (SMS) and print media, Widyalkara (2015) looks at the representation of Sinhala sounds through English characters referring to it as “interlingual texting.” Yet, her study claims that such representation leads to “ambiguity” and “unintelligibility” of the messages. No study has yet focused on the contact between the orthographic systems of Sinhala and English in digital Internet genres in an attempt to identify patterns emerging in such phenomenon, which leads to the research problem of the study:

How does Sinhala and English orthography come into contact in the use of English letters to represent Sinhala words in online text messages sent via mobile messaging apps such as Facebook Messenger, WhatsApp, and Viber?

1. What are the patterns of representing Sinhala vowel sounds in the word initial, medial and final positions in online text messages?

2. What are the patterns of representing Sinhala consonant sounds in the word initial, medial and final positions in online text messages?

The following are the objectives of the study:

1. To expand Johanson’s conception of “frequent copying” (2002, 2008).
2. To show the potential emergence of a new variety of Sinhala in which the orthographic system is a result of the contact between Sinhala and English orthography in online texting.
3. To challenge Gunasekar’s (1962) claim about the systems of transliteration of a (more) phonetic language by unphonetic English
4. To present an alternative viewpoint to widyalankar’s (2015) claim about the “ambiguity” and “unintelligillity” of sinhala messages reprentented using English characters.
5. To help develop more user-friendly Sinhala- English transliteration software.

## II. METHDOLOGY AND EXPERIMENTAL DESIGN

The data include online text messages sent through mobile messaging apps namely, Facebook Messenger, WhatsApp and Viber. These were collected from 20 undergraduates in the Faculty of Arts of the University of Colombo over a period of 10 months. A version of Milroy’s (1980) “friend of a friend” method was used to collect data in order to protect the privacy of the authors of the messages. Two friends of the researcher who had more access to the sample than the researcher were requested to obtain messages from their friends. The sample was selected based on the convenient sampling technique presuming that many individuals would be unwilling to share their messages due to the level of privacy attached to them.

The study uses Johanson’s (2002, 2008) “code-copying framework” as the principal method of data analysis. It also draws on the claims made by Gunasékara (1962), Vallins (1965), Crystal (2004) and Siromi Fernando (n.d.).

## III. RESULTS

The patterns of representing Sinhala vowel sounds using English letters in the word initial, medial and/or final positions can be categorized as follows:6

### A. The Representation of Spoken Sinhala Vowel Sounds

1. The use of (an) English symbol(s) to represent a Sinhala vowel sound in the word initial, medial and/or final positions where the particular symbol(s) is/are used to represent the same or a similar sound in Sri Lankan English. Below are some examples:

**Table 1. Spoken Sinhala long front low vowel ‘අඞ’ /æ:/**

English symbols used to represent the Sinhala vowel sound	Position in Sinhala words	Sinhala words	English words in which the said symbol produces the same or a similar sound	Position in English words
a	initial	athin / aæ:-tin/ අඞතින්	sand / sæ:nd/	medial
	medial	kama /kæ:-ma/කම		
	final	ba /bæ:/ බඞ		

2. The use of (an) English symbol(s) to represent a Sinhala vowel sound in the word initial, medial and/or final positions where the particular English symbol(s) is/are used to represent (a) different sound(s) in Sri Lankan English. Below are some examples:

**Table 2. Spoken Sinhala long front low vowel ‘ඒ’ /æ:/**

English symbols used to represent the word	Position in Sinhala words	Sinhala words	English words in which the said symbol produces the spoken Sinhala vowel sound	The sounds produced by the said symbols in English words
e	initial  medial  final	athin / aæ:-tin/ ඇතින් keli /kæ:li/ කලී ba /bæ:/ බැ	-	/e/ - get / get/ /i/ - kiss / kis/ /i:/ - mete / mi:t/
	initial  final	athin / aæ:-tin/ ඇතින් na /næ:/ නැ	-	/e:/ - jaeger /dʒe:ɡə:/
ah	final	ba /bæ:/ බැ	-	/a:/ - ah /a:/

3. The reduplication of an English symbol to represent a Sinhala vowel sound in the word initial, medial and/or final positions where the reduplication of the particular symbol represents a different sound in Sri Lankan English. Below are some examples:

**Table 3. Spoken Sinhala long back mid vowel ‘ඔ’ /o:/**

Reduplicated English symbol and spelling pattern	Sinhala words and positions in Sinhala words	English words in which the said symbols produce the spoken Sinhala vowel sound	The sound(s) produced by the said symbol(s) in English words
Symbol:oo Spelling pattern: oo	initial oolu /o:lu/ ඔලු final apoo /apo:/ අපෝ	-	/u/ good / gud/ /u:/ ooze /u:z/ fool /fu:l/ too /tu: /

4. The creation of a new spelling pattern that is not present in English to represent a Sinhala vowel sound in the word initial, medial and/or final positions through the reduplication of an English symbol. There are two types. Below are the two types with examples:

**4.1. The use of the particular symbol twice.**

**Table 4. Spoken Sinhala long front low vowel ‘ඒ’ /æ:/**

Reduplicated English symbol	New spelling pattern created	Position in Sinhala words	Sinhala words
a	aa	initial  medial  final	athin / aæ:-tin/ ඇතින් kaala /kæ:l-la/ කැල්ල ba /bæ:/ බැ

4.2. The use of the particular symbol more than twice.

Table 5. Spoken Sinhala long font low vowel ‘ආ’ /æ:/

Reduplicated English symbol	New spelling pattern created	Sinhala words	Position in Sinhala words
a	aaa	na /næ:/ නෑ	final

B. The Representation of Spoken Sinhala Consonant Sounds

The patterns of representing Sinhala consonant sounds using English letters in the word initial, medial and/or final can be categorized as follows:

1. The use of (an) English symbol(s) to represent a Sinhala consonant sound in the word initial, medial and/or final positions where the particular symbol(s) produce(s) the same or a similar sound in Sri Lankan English. Below are some examples.

Table 6. Spoken Sinhala dental unvoiced stop ‘ත’ /t /

English symbols used	Position in Sinhala words	Sinhala words	English words in which the particular symbol(s) produce(s) the same or a similar sound	Position in English words
th	initial	thibba /tʃib- ba:/ තිච්චා	thin/tʃn/ loathsome	initial
	medial	aththa /ættʃ ෑ / ඇත්ත	/lo:ts əm/ path /pa:tʃ	medial
	final	bath /batʃ/ ච්ච		final

2. The use of (an) English symbol(s) to represent a Sinhala consonant sound in the word initial, medial and/or final positions where the particular symbol(s) produce(s) (a) different sound(s) in Sri Lankan English. Below are some examples:

Table 7. Spoken Sinhala dental unvoiced stop ‘ත’ /t /

English symbol used	Position in Sinhala words	Sinhala words	English words in which the particular symbol(s) produce(s) the Sinhala sound represented	The sounds produced by the said symbol in English words
t	initial  medial  final	thibba /tʃib- ba:/ තිච්චා aththa /ættʃ ෑ / ඇත්ත behet / behetʃ/ ච්චෙහෙත්	-	/t/ - tin / tin/

V. DISCUSSION

In his description of “frequent copying,” Johanson (2002) says that “elements which already exist in the basic code...undergo an increase or decrease in frequency of occurrence” in the basic code (p. 292). The first three main patterns of representing Sinhala vowel sounds and two main patterns of representing Sinhala consonant sounds can be considered what Johanson (2002, 2008) refers to as “frequent copies” (p. 292, p. 74) for the frequent spelling patterns in the model code English are copied onto the basic code Sinhala. The first and second sub-patterns under the fourth pattern of representing Sinhala vowel sounds seem to reflect the feature of “Netspeak” which Crystal (2004) talks about – the use of “repeated letters (aaaaahhhh, hiiiiiii, ooooo) for emphasis” (p. 34). As shown in Crystal’s (2004) example, this feature occurs in the use of English on the Internet. Thus, they can also be considered “frequent copies.”

The copied English symbols are however, new to the basic code. Therefore, Johanson’s (2002, 2008) conception of “frequent copies” needs to be expanded. Accordingly, frequent copies can be referred to as elements which

already exist in the basic code and/or are new to the basic code which may undergo an increase and/or decrease in the frequency of occurrence. In this respect, elements which already exist in the basic code may undergo either an increase or decrease in the frequency of occurrence while the elements that are new to the basic code may undergo an increase in the frequency of occurrence.

The research participants' intense and regular use of the copied elements can be considered what Johanson calls "habitualization" (2002, p. 298, 2008, p. 65). As "habitualized copies", the patterns of representing Sinhala vowel and consonant sounds through English symbols identified in the study tend to "occur frequently, regularly and normally" among the research participants' texting (Johanson, 2002, p. 298). This frequent and regular use of the copies reflects a certain degree of "acceptance" of the copies by the bilingual research participants who seem to constitute a "speech community" (Johanson, 2002 p. 299, 2008 p. 65). However, it is necessary to observe the occurrence of the copies in the basic code over a longer period of time to identify them as "conventionalized code- copies" (Johanson, 2002, p. 299, 2008, p. 65), for "the process of conventionalization is a continuum of changes in sociolinguistic status with gliding transitions between degrees of acceptability for individuals and for speech communities" (Johanson, 2002, p. 300). Thus, the study which focuses on messages sent by informants over a period of 10 months can argue that the copies seem to appear only as "part of a more general bilingual norm" (Johanson, 2002, p. 299) and seem to be undergoing a process of conventionalization.

In relation to Johanson's (2002) claim that "language birth" may be the final result of conventionalization as the "high copying variety becomes the specific code of a whole speech community, including monolinguals" (p. 299), this study suggests that the linguistic phenomenon of using English letters to represent Sinhala vowel and consonant sounds in online text messages has potential to give birth to a new variety of Sinhala in which the orthographic system is a result of the contact between Sinhala and English orthography.

The patterns identified also challenge Gunasékarā's (1962) claim that "no system of transliteration of a phonetic language by an unphonetic one, like the English can ever be perfect" (p. 29). Just as there is a "method" in the "madness" or "inconsistencies" of English spelling (Vallins, 1965, p. 12), there is a method in the madness

or inconsistencies in representing Sinhala sounds using English letters although they reflect the complexity of the contact between a more phonetic language like Sinhala and a less phonetic language like English (Fernando n.d., p. 10). Some patterns used to represent Sinhala vowel and consonant sounds through English letters reflect how the Sinhala-English bilingual Internet user takes advantage of the "madness" or "inconsistencies" (Vallins, 1965, p. 12) of English spelling to suit his/her own agenda either by using an existing English spelling pattern to represent a different sound or by creating a new spelling pattern. Certain patterns involve a reduplication of an English symbol in the representation of a long Sinhala vowel sound. It is presumably because the particular English symbol is also used to represent the short vowel sound of the said Sinhala vowel sound. It seems to reflect the Sinhala-English bilingual Internet user's attempt to maintain the orthographic difference between the short and long Sinhala vowel sounds apparent in the Sinhala spelling system. This complexity of the representations of Sinhala sounds through English letters shows that the "unintelligibility" or the "ambiguity" of the Sinhala messages represented using English letters which Widyalkara (2015, p. 1) refers to could be subjective for it could be a result of a particular user's unfamiliarity with the patterns used by another user. These complex patterns of representing Sinhala vowel and consonant sounds through English characters are also useful to help develop more user-friendly online Sinhala- English transliteration software than the present ones which are unable to identify certain patterns of representing Sinhala vowel and consonant sounds through English characters (i.e. 'Google Input Tools') identified in the study or have their own transliteration schemes including capitalized English letters and punctuation marks which the users have to adopt when texting online (i.e. 'SinGlish Transliterated' and 'SinGlish (Phonetic) Transliterated').

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## NOTES

<sup>1</sup>Mendis (2006) notes that a “text message” is the popular name for SMS (Short Message Service) which is “a type of digital discourse that has come into being with the developments in mobile telephone technology” (p. 125). This study is on ‘online’ text messages which belong to “digital Internet genres” (Mendis, 2006, p. 125).

<sup>2</sup>Mobile messaging applications “allow you to send and receive pictures or text messages without paying for SMS” (Holt, Bossler & Seigfried-Spellar, 2015, p. 341).

<sup>3</sup>In the simplest definition, “language contact is the use of more than one language in the same place at the same time” (Thomason, 2001, p. 1).

<sup>4</sup>Speech sounds are certain acoustic effects voluntarily produced by the organs of speech; they require that the speech-organs shall be placed in certain definite positions or moved in certain definite ways” (Jones, 1969, p. 1). Rajapaksha says that spoken Sinhala has thirteen vowel sounds (1997, p. 12). Unlike Disanayaka, Rajapaksha does not include the mid central long vowel sound /ə:/ in his classification of vowels but the mid central short vowel sound /ə/ which he refers to as “schwa”. For a detailed illustration of the distribution of spoken Sinhala vowel and consonant sounds, see Disanayaka, 1991, pp. 65-124.

<sup>5</sup>“Letters provide a means of symbolizing sounds” (Jones, 1956, p. 11). The word ‘letters’ will be used interchangeably with the words ‘symbols’ and ‘characters’ in the study.

<sup>6</sup>Due to space constraints, the paper presents only a few examples of spoken Sinhala vowel and consonant sounds (for more examples, see Malalasekera, pp.19-69). Most examples of English words included in the tables are taken from Vallins (1965). For more examples, see Vallins, 1965, pp. 48-51. Note that Vallins (1965) uses IPA phonetic symbols while this study uses Fernando’s (1985) SLE phonetic symbols for it represents the Sri Lankan English pronunciation of the words. The phonetic symbols used by Weerasinghe et al. (2004-2007) are used to represent the Sinhala vowel and consonant sounds in the tables.

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# SINHALA AND TAMIL INFLUENCE ON SRI LANKAN ENGLISH PARTICLE USE: A CORPUS-BASED STUDY ON THE CASE OF 'FOR'.

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**Abstract** - Colonial expansion brought English into contact with different languages. In Sri Lanka, English has been in contact with Sinhala and Tamil for over 200 years. Today, all users of Sri Lankan English (SLE) are either bilingual or multilingual. In bilingual language processing, linguistic habits of one language exert influence on the other causing the latter to restructure. Although restructuring of a language in a language contact situation is overtly seen in phonology and lexis, syntactic and grammatical innovations are subtle and they take time to establish. When grammatical innovations do occur, they tend to begin at the intersection of grammar and lexis.

The present paper analyses the lexis- grammar interface of Particle Verbs (PVs) in SLE with special reference to the particle/preposition 'for'. The study uses a corpus-based methodology, and data are from the Sri Lankan, Indian, and Great Britain components of the International Corpus of English and Corpus of Global Web-based English. Results are presented of two PVs, 'sit for' and 'contest for', which are innovations having significant frequency of occurrence in SLE data.

When these structures are compared with their corresponding equivalents in Sinhala and Tamil, it is revealed that the case environments of the relevant verbs in Sinhala and Tamil make it compulsory for those equivalents to have a counterpart for 'for'. This may be why SLE prefers these PVs, while its historical input variety, British English, prefers simplex verbs without the particle, i.e. 'sit' and 'contest', to convey the same idea.

**Keywords** - SLE, Particle Verbs, language contact, corpora

## I. INTRODUCTION

Although English was originally the language of the people of England, it has been displaying the feature of widespread expansion right from its origins. In the 16th and 17th centuries, it spread to Wales and other British Isles such as Scotland; then, with the movement of English speaking populations, it spread to other 'Inner Circle' countries like America, Canada, Australia, and New Zealand (cf. Kachru, 1992). Later introduction of English to Asian, African, and Latin American countries with the British and American colonial expansion, however, brought it into contact with a large number of other genetically and culturally unrelated languages (cf. Bhatt, 2001). As a result of this widespread movement of English, a large number of International Varieties of English (Crystal, 1995) have emerged. Sri Lankan English (SLE) is one such variety of English.

The English language reached Sri Lanka with the arrival of the British East India Company in 1796. Since then, it has been in contact with the two prominent local languages of the country- Sinhala and Tamil. Additionally, as Mendis & Rambukwella (2010) observe, all speakers of SLE today are bilingual and some are trilingual. In bilingual language processing, one language exerting influence on the other (and vice versa) is inevitable, and it results in restructuring of the systems of the contact languages. Restructuring of languages in a contact situation can affect all systems of a language. Of these, phonology and lexis are the most affected. In contrast, syntax and grammar tend to be much more stable and resistant to change comparatively. As Schneider (2007) points out, when grammatical

innovations do emerge, they start out at the intersection of grammar and lexis. World Englishes (WE) literature has already recorded that innovations in the lexis-grammar interface such as different complementation patterns of verbs, co-occurrence and collocational tendencies of words in phrases, and patterns of word formation can be found especially with regard to WEs (Schneider, 2004). Particle/preposition use, which is the object of investigation in the present study, is also common among such lexis-grammar innovations.

The object of investigation in the present study is termed 'particles' following the tradition of the WE field as a neutral cover term for prepositions and spatial adverbs, as was done by Schneider (2004). Since the focus of the present paper is only on the particle 'for', the term 'prepositions' could also have been used. The term 'particles' suits better, nevertheless, because references are made in the paper to Sinhala and Tamil as well. Although Sinhala is an Indo-Aryan language and Tamil a Dravidian language, both have 'postpositions' rather than 'prepositions'. Additionally, both in Sinhala and Tamil, not only postpositions but also case inflections play a role in performing the functions of prepositions/particles in English. Thus, certain meanings expressed by the English particle *for* are represented in Sinhala by the Sinhala dative suffix /tə/ and in Tamil by the Tamil dative suffix /kku/. In addition, certain meanings expressed by the English particle *for* are represented by the Sinhala postposition /saḍḍiḥa:/ and the Tamil bound postposition /a:ka/ (Lehmann, 1989).

The lexis-grammar interface of the particle 'for' (or any other particle for that matter) can be studied when it goes into combinations with verbs, adjectives, nouns etc. The focus of the present paper is verb-particle combinations, which is, perhaps, the most frequently discussed combination with particles in WE literature. The term 'Particle Verb (PV)' is used to refer to such combinations in the present paper following Zipp (2014), who adapted the term from Quirk et al (1985) as a cover term for all combinations of verb and particle, subsuming the three main categories defined in Quirk et al (1985): phrasal verbs, prepositional verbs, and phrasal-prepositional verbs. In fact, the PVs with 'for' discussed in the present paper fit prepositional verbs category out of these three categories. Only those PVs with 'for' having objects that answer the questions 'who' and 'what' are used for analysis (as opposed to those answer questions 'when', 'where' etc., which are free adverbial combinations).

## II. METHODOLOGY AND EXPERIMENTAL DESIGN

The present study employs a synchronic, corpus-based methodology as its principal analytical procedure. Performance data for the linguistic analysis are extracted from 2 types of written language corpora representing SLE, which are compared with data from parallel corpora representing British English (BE), the historical input variety of SLE; as well as Indian English (IndE), in order to effectively evaluate the significance of occurrence of selected structures in SLE. The term corpora (singular corpus) is used in the present paper to refer to collections of texts or transcribed speech that are representative of a language, and are stored and accessed electronically.

The first type of written language corpora of the present study's corpus environment is from the written parts of the respective components of International Corpus of English (ICE) (Greenbaum, 1996), namely Sri Lankan component (ICE-SL), Great Britain component (ICE-Gb), and Indian component (ICE-Ind). ICE corpora provide comparable language data from each variety with a high level of representativeness covering a wide range of genres. Each written component of the ICE consists of approximately 400,000 words. The second type of written corpora used in the analysis is a large online database recently made available. It is the corpus of Global Web-based English – GloWbE (Davies & Fuchs, 2015), which is composed of 1.9 billion words in 1.8 million web pages from 340,000 websites (including online newspapers and blogs) in 20 different English-speaking countries. The relevant components to the present study contain 46,583,115 words of SLE (GloWbE-SL), 96,430,888 words of IndE (GloWbE-Ind), and 387,615,074 words of BE (GloWbE-Gb). This large database is useful in detecting those innovative features of SLE which are low-frequency phenomena.

Selection of only written language data in the present study is motivated both by practical and theoretical reasons. Practically, as the spoken part of ICE-SL is still in the compilation stage, there are no standard corpora of SLE representing spoken data. Compiling a sufficiently sized representative corpus of spoken SLE is also beyond the scope of a study like the present study. Theoretically, although linguistic innovations are considered to be accumulated in genres of spoken language at first, their infiltration into written genres signals the advancement of a variety through its evolutionary stages. According to Schneider (2003, p.252), interaction between spoken

behavior and written norms in a society takes place in the phase of endonormative stabilization, with codification. Thus, it is hypothesized that the appearance of distinctive features of SLE in standard written language corpora, covering a wide range of both formal and informal genres, signals that SLE is reaching the stage of endonormative stabilization.

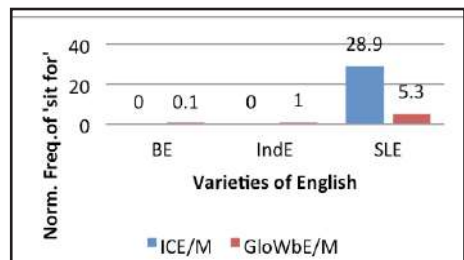
ICE corpora data were analyzed using the concordancer (corpus access software), Wordsmith Tools-Version 5 (Scott, 2008), with 'for' as the search word and verbs occurring with it at positions 01, 02, and 03 to the left of it (L1, L2, and L3) as collocates in all three written components. In order to exclude adverbial combinations, all concordance lines were manually read. The frequencies of the selected concordances were normalized to 1 million words because the word counts of each ICE component are not exactly the same. Selected PVs in the three ICE components were, then, categorized as recorded, partly-recorded, and unrecorded based on the combinations' extent of availability in the online dictionaries indexed at Onelook dictionary search <<http://www.onelook.com/>>. If the combinations are not recorded in any of the online dictionaries indexed at Onelook dictionary search, they were categorised under unrecorded. If the combinations are available in a wide range of dictionary sites indexed at Onelook dictionary search, including Oxford, Cambridge, Collins, or Macmillan, they were categorised under recorded. If they are not recorded in any of the above dictionary sites, but recorded only in the online The Free Dictionary, they were categorised under partly-recorded. From the unrecorded PVs, those that occur 05 or more times in ICE-SL were considered for evaluating contact language influence.

Additionally, as ICE corpora are comparatively small in size, unrecorded and partly-recorded PV types selected through the analysis of ICE corpora data were searched in GloWbE corpora using its online interface as the concordance under individual scholar license. With GloWbE, the verb (lemma) was used as the search term, and 'for' as the first collocate to the right of the verb lemma for brevity's sake (without going to the second and third position to the right). The frequencies of these PV types in GloWbE corpora were normalized to 100 million words, and those that hit over 100 normalized counts of the raw frequencies in SL component were manually read in order to exclude adverbial combinations. In addition to the significantly frequent PVs selected through the analysis of ICE and GloWbE corpora data, PVs already recorded in WE literature were also searched in the two corpus environments.

### III. RESULTS

The page length restrictions of the present paper do not warrant reporting the complete results of the study. Therefore, the results of only two PVs that show evidence of local language influence are discussed here: The first, 'sit for', is found through the analysis of ICE corpora data, and the other, 'contest for', is described through the analysis of GloWbE corpora data.

Among the unrecorded PVs that are 05 or more times frequent in ICE-SL, 'sit for' meaning 'take an exam' triggered particular interest of the present study because Gunesequera (2005) outlines this as a case of 'overuse of prepositions', which, according to her, is a characteristic of SLE syntax. She explains that the preposition 'for' in the sentence 'they did not sit for the exam' is not required because the structure 'sit the exam' alone 'works'. This PV occurs 14 times in ICE-SL data, whereas both ICE-GB and ICE-Ind show no occurrence of it. Figure 1 below shows normalised frequencies of the PV 'sit for' occurring in the three components of ICE and GloWbE. Data in the figure show that the presence of this PV is highly significant in SLE, whereas in IndE and BE, its presence is marginal, more so in the latter.



**Figure 1. Frequencies of 'sit for' in the three components of ICE and GloWbE normalised to 1 million words.**

As this PV is an instance of an 'addition of a particle' (to the simplex verb 'sit'), the occurrence of the simplex verb 'sit' to convey the same meaning was examined. Figure 2 below shows normalised frequencies of the PV 'sit for (an exam/test)' and its single-verb alternative 'sit (an exam/test)' in the three ICE-components.

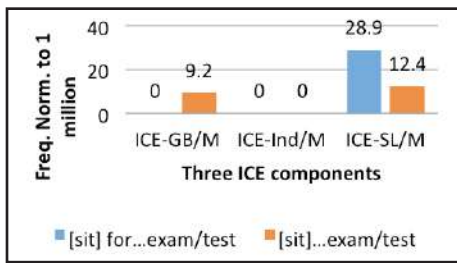


Figure 2. Normalised frequencies of 'sit for' and 'sit' in the three ICE-components

As depicted in Figure 2, written component of ICE-Ind records neither the PV nor the simplex verb, while ICE-GB attests only the simplex verb. ICE-SL shows the occurrence of both the PV and the simplex verb, but with a clear preference for the former. Cross-checking with 1000 random hits of the lemma [sit] in GloWbE components too produced similar results (Figure 3).

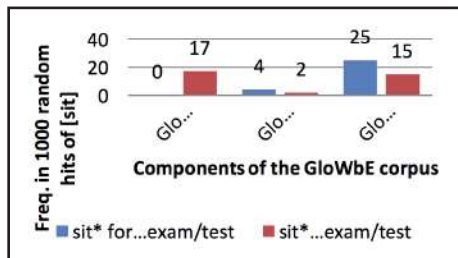


Figure 3. Frequencies of 'sit for' and 'sit' in 1000 random hits of the lemma [sit] in the three GloWbE components

Data depicted in Figure 3 show statistically significant differences at  $p < 0.001$ ,  $df=2$  ( $\chi^2 \approx 19.90$ ) and a 'redundant' correlation (Cramer's  $V \approx 0.56$ ). Further, as elaborated by Figures 1 through 3, the two 'new' varieties of English (SLE and IndE) tend to prefer the innovative combination 'sit for' over the simplex verb 'sit', continued from the historical input variety (BE). For BE, the preference is still the simplex verb.

Key Word In Context (KWIC) lines (concordances) for 'sat for' extracted from the written component of ICE-SL, which are depicted in Table 1 below, show that six out of the nine concordance lines are from the text category W2A, which is Academic Writing (Printed), and the others are also from printed categories; Instructional Writing (W2D) and Creative Writing (W2F).

Table 1. Concordances for 'sat for' from ICESL written component and their text category names

Concordance line	Text category
after we left the school we sat for the public service exam	W2F-006.txt
stem Music privately and sat for the examination throug	W2D-018.txt
hic AllianceAlliance "After I sat for this course, I knew wh	W2D-011.txt
the students who have not sat for or passed GCE (AL), n	W2A-008.txt
MCQs of all trainees who sat for the pre and post tests	W2A-006.txt
istrict (NTH) all 9 trainees sat for both pre and post tests	W2A-006.txt
9 participants respectively sat for the pre-test and partici	W2A-006.txt
ly the marks of those who sat for the post-test were use	W2A-006.txt
e A total of 3477 students sat for the Grading Tests in 1	W2A-005.txt

The concordances for 'sit\* for' from ICE-SL given below show that this PV appears in Non-printed text categories W1A (Student Writing) and W1B (Letters) as well (Table 2). In GloWbE-SL, the PV occurs in online written genres including blogs. Thus, it is quite obvious that this PV is used in a wide range of written genres in SLE, including very formal genres such as Academic Writing.

Table 2. A section of concordances for 'sit for' from ICE-SL written component and their text category names

Concordance line	Text category
when i come back i have to sit for 4 papers! NOT fun! (bl	W1B-006.txt
s of all those who could not sit for the post-test have been	W2A-006.txt
be chosen even though they sit for the exam the next time	W1A-012.txt
Thirteenthirteen years they sit for A/L's which desidedeci	W1A-012.txt

The second PV analysed in the present paper, 'contest for', was culled from Nihalani (2004) with regard to IndE. This PV was found to be significant in SLE through the analysis of GloWbE corpus data. The absolute frequencies of this combination are higher in the two new varieties of English than in BE (Figure 5). With regard to frequencies normalised to 100 million words, this variation is significantly pronounced specially in SLE, in which the figure even exceeds 100 (120), whereas BE records only 11 occurrences. The written components of the relevant ICE corpora, however, do not record this combination.

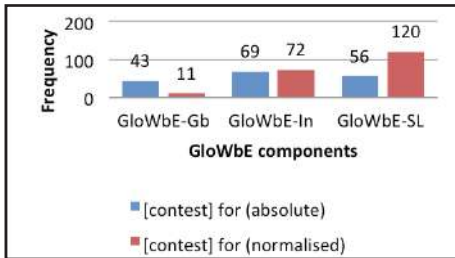


Figure 5: Absolute and normalised frequencies of ‘contest for’ in the three GloWbE components

This PV too appears to be a case of an ‘addition of a particle’ (to the simplex verb ‘contest’). Therefore, total occurrences of the lemma [contest] were sought in GloWbE corpora. As the occurrence of the verb lemma itself is higher in the two new varieties, frequency counts of the PV were worked out as a percentage of the counts for the entire lemma. As can be seen in Figure 6 below, the PV’s occurrence is significant in the two new varieties of English as a percentage as well (more so in IndE though).

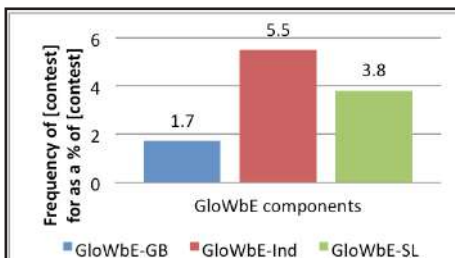


Figure 6: Frequency of ‘[contest] for’ as a percentage of the frequency of [contest] in the three GloWbE corpora

#### IV. DISCUSSION AND CONCLUSION

The results of the corpus data analysis presented in the previous section show that the frequency of occurrence of both of the analysed PVs stands out in the two new varieties of English. Previous studies in the field also reveal that lexico-grammatical innovations in new varieties of English don’t necessarily stand out categorically from the more established varieties (such as BE), but only show frequency-related differences with them (cf. Mukherjee 2007, p.175; Bernaisch, 2015, p.137).

In light of the significant frequency of occurrence and widespread distribution of the PV ‘sit for’ in SLE, it is

important to trace the diagnostic processes that may have led to the creation of this innovation. An analogy based explanation is difficult to trace because, for one, the verb ‘sit’ in this combination (in the context of exam/test) is used in a rather figurative sense (meaning ‘take an exam’ or ‘appear for an exam’). Further, most of the other verbs that collocate with exam/test, such as take, pass, write, and fail do not provide a model (such as \*take for an exam or \*pass for an exam) for this combination with the particle ‘for’. Therefore, it is worth tracing the possible contact effects from Sri Lankan local languages, Sinhala and Tamil.

The figurative use of ‘sit for’ in the context of ‘exam/test’ finds its equivalent in less formal Sinhala. In more formal Sinhala, an equivalent of ‘appear’ (for), /peni:sitiŋəvʌ/, is used in this context. The equivalent of ‘for’ in this PV, /tə/, manifests as a dative suffix for the prepositional object of the construction as shown below:

Sinhala: /vibə:geʔə va:divenəvʌ/  
 Gloss: the exam for sit  
 SLE: sit for the exam

The case environment of the Sinhala verb, /va:divenəvʌ/, is such that the preceding noun taking the suffix, /tə/, is mandatory. Thus, the following construction is unacceptable in Sinhala:

Sinhala: \*/vibə:ge va:divenəvʌ/  
 Gloss: the exam sit  
 SLE: sit the exam

The other Sri Lankan local language, Tamil, too has an equivalent for ‘sit for...exam/test’. In Tamil too, the equivalent of ‘for’ is a dative suffix, /kku/, as illustrated below:

Tamil: [avarka] aʈuttamurai paɾiʈcaikku amavarka]  
 Gloss: they next time exam for sit  
 SLE: They sit for the exam the next time

Just as in Sinhala, this case marking is mandatory in Tamil, making the following construction unacceptable in Tamil:

Tamil:\*[paɾiʈcai amavarka]  
 Gloss: the exam sit  
 SLE: sit the exam

Thus, the equivalent of ‘sit the exam’ being absent in Sinhala and Tamil, and only the equivalent of ‘sit for the exam’ being present in the two local languages may have contributed to the significant, widespread occurrence of ‘sit for the exam’ in SLE. This corroborates Schneider’s (2007, p.107) position on ‘contact’ as a linguistic process which triggers or accelerates various types of innovation. Examination of the ICE-SL metadata reveals that in seven

out of the ten texts from which the 14 occurrences of ‘sit for...exam/test’ come, the informant has Sinhala first language background, while in two texts the informant has Tamil first language background. In the remaining text, the metadata information is not sufficient to trace the first language background of the informant. Hence, the possible transfer effect for the said structure seems to be from both Sinhala and Tamil. Perhaps, fewer instances of the PV have been recorded from informants with Tamil first language background because of the lesser proportion of such informants in the SLE speech community.

As with ‘sit for’, in the corresponding Sri Lankan local language structures of ‘contest for’, an equivalent for the particle ‘for’ is mandatory. There are two main equivalents in Sinhala for the particle ‘for’ in ‘contest for’. One is a postpositive particle, /səḍḍəha:/, which is more formal, and the other less formal equivalent is the dative suffix /tə/. The following structures illustrate these uses:

Sinhala: /ohu məɪtɪvərənəyə səḍḍəha: tərəḡəkərai/  
 Gloss: he the election for contests  
 SLE: He contests for the election.

Sinhala: /ohu məɪtɪvərənəyə tə tərəḡəkəranəva/  
 Gloss: he the election for contests  
 SLE: He contests for the election.

Since the case environment of the Sinhala verb, /tərəḡəkəranəva/ (kərai) makes the structure to have the suffix, /tə/ (less formal versions), or the postpositive particle, /səḍḍəha:/ (more formal versions), mandatorily, the constructions below are less acceptable in Sinhala (though not totally unacceptable):

\*Sinhala: /ohu məɪtɪvərənəyə tərəḡəkərai/  
 Gloss: he the election contests  
 SLE: He contests the election.

\*Sinhala: /ohu məɪtɪvərənəyə tərəḡəkəranəva/  
 Gloss: he the election contests  
 SLE: He contests the election.

As the following structure illustrates, in Tamil too an equivalent for the particle is mandatory in this combination:

Tamil: [ Annatturai pārāḷumaṅṅam pōṭṭiyittār ]  
 Gloss: Annadurai the parliament for contested  
 SLE: Annadurai contested for the parliament.

For this reason, the structure below, which is without the particle, is less acceptable in Tamil as well. Thus, the mandatory particle use in the Sri Lankan local languages, Sinhala & Tamil, in the equivalent of this PV may have contributed to its significant occurrence in SLE data.

\*Tamil: [ Annatturai pārāḷumaṅṅam pōṭṭiyittār ]  
 Gloss: Annadurai the parliament contested  
 SLE: Annadurai contested the parliament.

Because the compulsory requirement of having an equivalent for ‘for’ in this PV is there both in Sinhala and Tamil, it is possible that the contact effect is from both Sinhala and Tamil. However, unlike with ‘sit for’, it is difficult to trace the first language backgrounds of the informants of the concordances of ‘contest for’ because it is only attested in GloWbE corpora data. As GloWbE corpora are based on webpage data, comprehensive metadata about the sociolinguistic backgrounds of the informants are absent, which is one disadvantage of GloWbE corpora in comparison with ICE corpora. Nevertheless, ‘contest for’ itself shows a strength of GloWbE corpora over ICE corpora; that the PV was found in none of the relevant ICE corpora, but was found over 100 instances in some GloWbE corpora. GloWbE corpora thus have the advantage of attesting low frequency structures. Additionally, it should also be mentioned that the PVs, especially ‘contest for’ was found to be in a significant frequency in IndE data as well. This does not negate a possible contact language influence in SLE, however, because major local languages in India are also from Indo-Aryan and Dravidian families just as the major local languages in Sri Lanka.

In conclusion, the foregoing discussion makes it evident that the PVs ‘sit for’ and ‘contest for’ exemplify lexicogrammatical innovations in new varieties of English, particularly in SLE. Infiltration of these PVs into genres of written language (including Academic Writing) testifies that they are being accepted in terms of variety internal norms. Whereas the historical input variety of SLE, i.e., BE, is found to prefer the simplex verbs without the particle, SLE prefers these PVs with the particle. Thus, the two PVs are instances of ‘addition of a particle’ to a simplex verb to form new PVs, which is said to be a feature of New Englishes. The analysis of corresponding Sinhala and Tamil equivalents revealed that for both PVs an equivalent for the particle ‘for’ is mandatory in Sinhala and Tamil structures, and structures without the particle are unacceptable or less acceptable in Sinhala and Tamil. Hence, it can be argued that in the process of bilingual processing of language, SLE users bring their habit of using a particle in the Sinhala and Tamil equivalents of these structures into the English structures, thus preferring the PVs over the simplex verbs. Therefore, it can be posited that these PVs show influence of Sinhala and Tamil on SLE particle use. However, these findings have to be substantiated in a future study

using another experimental procedure such as elicitation techniques in order to investigate the extent each contact language exerts such influence.

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# THE IMPACT OF PARENTAL INVOLVEMENT ON STUDENTS' ATTITUDE AND PERFORMANCE IN SCIENCE IN BATTICALOA EDUCATIONAL ZONE, SRI LANKA.

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**Abstract** - This study was carried out to find the impact of parental involvement on student's attitude and their performance in science subject. A sample survey design was adopted for this study. The study was directed at the population of senior secondary students in the Batticaloa educational zone, in the Batticaloa district of Eastern Province in Sri Lanka. The sample was 400 students who studied in grade 12 and 13 science and mathematics streams and offering the physics and chemistry subjects. Ten 1AB schools from this research area were selected for the study. The 1 AB schools in Kalmunai zone were stratified into urban and semi-urban schools. 40 male and female students from the grade 12 and 13 were randomly selected with (late adolescent. To make the total of 400 respondents, 40 were selected from all 10 schools to constitute the sample for this study. The schools consist of 4 semi-urban and 6 urban schools was selected for this study.

The students' questionnaire, consists of section A which is made up of 24 questions, measuring the attitude of the students while the section B contain 18 questions for measuring the parental involvement (home influences) items. They were Likert scale item type questions, in which respondents choose from 5 point scores such as strongly, agree to strongly disagree. Thirdly, information concerning the individual performance (in percentages) of students

was obtained from their continuous assessment records of the school subjects concerning (physics and chemistry). Three null hypotheses were postulated and tested at 0.05 level of significance to the impact of parental involvement on student's attitude and their performance in the science subject. Data collected on the study were analysed using inferential statistics which include; student analysis of variance (ANOVA) and Pearson product Moment correlation coefficient. The result of the study showed that there is a significant relationship between students' attitude towards performance of physics and chemistry and their parental involvement ( $p=0.012$  and  $0.026$  respectively). And there is a significant relationship between performance of physics and chemistry and their parental involvement ( $p=0.019$  and  $0.031$  respectively). The correlation of coefficient between attitude and performance (physics and chemistry) are positively and significant ( $r=0.66$ ,  $p=0.013$  and  $r=0.53$  and  $p=0.019$  respectively). The phenomena observed were discussed in the light of prevailing conditions in most of the developing countries. Conclusively, home influence can be a tool to enhance school learning.

**Keywords** - Attitude, performance, parental involvement, Secondary 1 AB school, and late adolescent.

## I. INTRODUCTION

Home influence can be identified as very important variable that have potential for promoting directly or indirectly student academic achievements (Fehrmann et.al, 1987). The term parental involvement has been given different meanings. It has been used to mean parental expectation of school performances, (Seginer, 1983); deliberate effort by the home to reinforce improved academic performance (Fehrmann et.al, 1987 ; Fontana, 1981) ; general academic guidance and support (Seginer, 1983) ; students perceptions of the degree to which their parents influence their plan for high school and monitor their daily activities and school progress (Ogunniyi, 1996), parental influence as determinant of attitude towards learning, (Oguntelure, 1987), contribution to children's activities (home work, encouraging children to read), and promoting school and school based activities (attending parent teachers' association meetings, parent teachers conference and participating in fundraising activities (Olatoye and Ogunkola, 2008). Ogunniyi (1996) identified four major factors responsible for poor performance in science subject. These factors are;

1. Teacher related (e.g. bad teaching, unpleasantness Fehrmann et.al., (1987) emphasizes that better learning achievement of students is ultimately determined in the classroom by motivated teachers who have the skills and resources to respond effectively to students' learning needs.
2. Pupil related (e.g. socio cultural background that is indifferent to the learning of science. (Ogunniyi, 1996), attitudes, interest, and learner related influences etc.). According to Olatoye and Ogunkola (2008) the cooperation of students, their parents and teachers can be very valuable.
3. Authority related (e.g. poor management, wrong priority, vision, standards, incentives, curriculum etc.)
4. Subject content related (e.g. difficult concepts)

The major concern of this research is to look into parental influence on the attitude and academic performance among secondary school (senior secondary students grade 12 and 13 science streams) students. In spite of the fact that observable attitude of the student have been produced by combination of variables, as earlier mentioned, it is possible to identify the effect of "home

influence" on attitude, enrolment and performance in science. If this psychological construct called attitude, having been mentioned as one of the three main factors affecting performance in science (Aghanta, 1982) ; it is important to find out if there is any relationship between it and parental influence. Can positive influence from parents and interested members of the public help to produce enough science-oriented students to read science based course and provide manpower in the new science areas of science based occupations?

## II. REVIEW OF THE LITERATURE

**Attitude** – Attitude is a concept, which arises from the attempt to account for the observed regularities in the behaviour of individual persons, the quality of which is judged from the observed evaluate responses one tends to make. An individual can show positive or negative attitude towards a particular object, subject or idea. Kind et. Al., (2007) viewed attitude as having different components which include cognitive (knowledge, belief and ideas) ; affective (feeling, like, dislike) and behavioural (tendency towards an action). The attitude that one has towards an object makes one to make judgment as to whether the object is good or bad harmful or beneficial, pleasant or unpleasant important or unimportant, Crano and Prislin (2006), Epstein et.al., (1997) identified six areas of parental involvement in their children's academic activities. These are parenting, communicating, volunteering, learning at home, decision making and collaborating with the school. According to him, if they are actively involved in all these area, no doubt it will stimulate in school and influence academic achievement. Due to the great influence of attitude on educational pursuits, it is worthwhile to identify the determinants of attitude towards a particular object, subject or idea, the chief of which are hereditary factors, body, state, direct experience and communication. Hereditary factors (that is, inheritance from parents) from the basis of all human activities including developing of attitude as well as learning. Sometimes unconsciously parents and guidance through non-verbal communications transfer their, likes and dislikes to children via bodily movements and facial expression.

**Parental Involvement** – Children who are academically successful hold positive attitude school and are well adjusted emotionally and socially (Jeynes, 2005). The academic success is due to the children's innate abilities and reflect the advantage of being in the socio-economic level (Crano and Prislin, 2006). Children who are

economically advantaged receive enough stimulation at home thereby enhancing their academic achievement (Olatoye and Ogunkola, 2008). Parents' high aspiration does have additional benefit over and above the advantages children enjoy from being capable and receiving adequate stimulation and resources. One study found that higher level of parental aspiration lowered the likelihood of academic failure during secondary school by 48% compared with equally poor but low aspiring parents (Oguntelure, 1987; Aghanta, 1982; Epstein et.al., 1997).

Jeynes(2005) identified five dimension of parental involvement, there are;

- a. Non-participation – Parents are not involved in their children's learning. These active non-participant parents are may have decided not to be involved. They may either be satisfied with what the school is offering, or are too busy at work, or wants time away from their children. Some of the parents passive simply because they lack confidence or may be unhappy with the form of partnership the school offers.
- b. Support – This dimension of parental involvement s only when parents are invited to attend events, e.g. parent/teachers' meeting, contributing to developing school policies, or by providing money for learning resources. This is a form of direct involvement.
- c. Participation – Parents may wish to participate as helpers providing assistance on outing, running a toy library, supporting children's learning in the setting and providing indirect support at home that is, keeping informed about what happens toothier children at school, monitoring their academic progress, reading to them and providing intellectual activities for them at home and within the community.
- d. Partnership – This dimension of parental involvement is a wide scope comes inform of partnership with practitioners. As a result of equal access to information and records some parents may share in the diagnosis and assessment of their children, or involve in the selection of practitioners, or become parishioners.
- e. Control – In this case, parents determine and implement decisions.

Direct experience by learners is one of the most important determinants of attitude. Parents/guardians need to influence their children by increasing familiarity in the science subject, taking interest in their school work, enrol them for extra lessons, ensuring that home work is done, acquire film and other electronic material that can stimulate their interest in science based careers and enable the children to develop friendly attitude towards the science subject. These experiences are effective in removing hostility towards school work. The effectiveness with which parents are able to motivate their children to learn science by way of enhancing their home and school learning environments is a function of their socio-economic status. The fact that there is a positive relationship between parental influence, which is a indices of socio-economic status pf parents and the academic progress of their children is established by Aghanta, 1982 ;Willms (1986) ; and Oluwatelure (2009).

Our modern society is faster paced, globally networked, technologically oriented and requires workers who can solve problems and think critically. The Americans believed that poor ability in science, mathematics and technology will certainly hamper their leading role in the global village Knuth et.al., (1991). Hence the initiative that lead to the creation of a community based collaborative approach, involving the family-school-community partnership, to establish "after school programme", which was meant to improve the whole the child. The negative attitude of students which is confirmed by poor performance in science ; (Olatoye, 2004 ; Ogunniyi, 1996) ; needs to be reinforced through collaborative efforts of parent/guardians, communities and the school. Parent, irrespective of their economic status, are important stakeholders in the education sector and can actually challenge the incompetent nature of science teacher, lack of commitment as well as the slow national approach to science education reform. Stelioset.al., 2007 were found that literate parents will actively support the education of their children. There is an emphasis on the culture of quality as the only avenue through which schools in Africa can develop and survive. There is the belief that centralization should give way to parental and civil society participation. It was reported that in the exploration of nine countries in Africa, little parental or civic involvement was found. Parents and community participation in the African schools, is seen as a key element of success (Ogunniyi, 1996).

### III. STATEMENT OF THE PROBLEMS

Vast majority of parents are finding it more and more difficult to make a living, especially in developing and undeveloped countries; scarcity of food especially due to its diversion to the production of chemicals, drugs and ornaments present enough reason to be distracted from the expected monitoring in various aspects of children's life. The challenges of single parenthood, family crises and the ever increasing involvement of women in various areas of community and national development makes one to ask questions as to whether parents are still able to be committed to their wards; or whether they are putting enough efforts towards effective learning of science among children. This research work therefore seeks to find out the extent to which parents have been able to objectively use their position to enhance academic progress in their children.

### IV. PURPOSE OF THE STUDY

If parental influence becomes exerted on pupil through inheritance and communication and by providing right and stimulating environment, the main focus of this research is therefore to find out if there is home/social class advantage. In other words, this study was geared towards finding out if positive attitude as well as academic progress of students from parents with high involvement will be better than their counterparts from parents with low involvement. The researcher also seeks information as to whether there will be any relationship between attitude to and performance in science.

### V. RESEARCH HYPOTHESES

The following hypotheses were raised to guide the study.

- H<sub>1</sub> - There is no significant relationship between students' attitude (towards their physics and chemistry) and their parental involvement.
- H<sub>2</sub> - There is no significant relationship between students' performance in science (physics and chemistry) and their parental involvement.
- H<sub>3</sub> - There is no significant relationship between students' attitude and academic performance in science.

### VI. METHODOLOGY

#### 1. Population and Sample

A sample survey design was adopted for this study. The study was directed at the population of senior secondary students in the Kalmunai educational zone, in Amparai district of Eastern Province in Sri Lanka. The sample was 400 students who were studied in grade 12 and 13 science and mathematics stream and offering the physics and chemistry subjects. The selected ten 1AB schools from this research area. This zone is one of the 5 zones in Amparai district. It has cultural and educational similarities with the other zone in the Eastern Province. These schools were situated in the urban and semi-urban area, and there is no 1AB schools in the rural area. The 10 1AB schools in Kalmunai zone were stratified into urban and semi-urban schools. The selected ten 1AB secondary schools consist of four educational divisions in Kalmunai zone. The 40 students were randomly selected with male and female among the grade 12 and 13 (late adolescent) and to make a total of 400 respondents from 10 schools that constituted the sample for this study. The schools consist of 4 semi-urban and 6 urban schools were selected for this study.

#### 2. Instrumentation

The following research instruments were selected and used in the study. The main instrument for collecting data, was a questionnaire. The questionnaire was selected as the chief method because of its many advantages. It gives maximum coverage of the field of study, in comparison with other tools of student's motivational aspects. The students' questionnaire was divided into two parts. It consists of section A which is made up of 24 questions, measuring the attitude of the students while the section B contains 18 questions for measuring the parental involvement (home influences) items. It was a scale of likert type question format (five point scale) with response ranged from strongly agree (SA)-4, agree (A)-3, undecided (U)-0, disagree (D)-2 and strongly disagree (SD)-1 to strongly disagree 1. To ascertain the reliability of the instrument after modification, it was administered on 25 respondents who were science and mathematics stream students selected from another two secondary 1AB schools which were not part of the study sample. The attitude questionnaire designed and standardized by the researcher (split half reliability coefficient 0.62 and 0.69 for physics and chemistry respectively) was administered to determine the attitude of senior secondary school students.

towards two of the science subjects namely; Physics and Chemistry.

Section A exploring this attitudinal construct, items were drawn relating to concept which are important components of the attitudinal measures considered in this research. They were Likert scale item type questions, in which respondents choose from 5 point scores such as strongly agree to strongly disagree. The following items were contained the 24 questions;

- i. Interest or enjoyment of the subject.
- ii. Perception of the subject.
- iii. Perception of value of subject (that is, usefulness)
- iv. Assessment and performance (that is, ability)
- v. Attitude towards teachers teaching the subject.
- vi. Attitude towards content of the subject.
- vii. Outside pressure (that is, home influence)
- viii. Attitude towards self (that is, positive or negative relation to subject)
- ix. Fear and anxiety.

Section B exploring the 18 questions which were responded to under home influence (parental involvement) were related items. These questions were focus on following items;

- i. Extra lesson/home work.
- ii. Occupational/status of parents.
- iii. Educational attainment level of the parents.
- iv. Materials possession in the home.
- v. Cultural level of the home.
- vi. Parents attitude to the education
- vii. Leisure.
- viii. Time spent on domestic and commercial affairs.

The total number of items in the questionnaire 42 and they all measured the same construct. Thirdly, information concerning the individual performance (in percentages) of students was obtained from their continuous assessment records of the school subjects concerned (physics and chemistry). Copies of the questionnaire were administered to the students by the researcher and collected from them immediately after completion of the questionnaire.

### 3. Scoring procedure

The questionnaire were scored using the Likert system. For positive statements, responses were assigned 4,3,0,2, and 1 as the scores for choosing SA, A, U, D or SD respectively, while negative statements were scored in the reversed order, and the summed scores obtained for each respondent. The items under home influence were scored separately and converted into percentage.

## VII. DATA ANALYSIS AND RESULTS

Data collected on the study were analysed using inferential statistics which includes; student analysis of variance (ANOVA) and Pearson product Moment correlation coefficient. The data obtained were analysed using ANOVA for hypothesis 1 and 2 and Pearson product Moment correlation coefficient for hypothesis 3. Specially, the study provided answers to three research hypotheses. The sequence of the presentation of the results is in accordance with that of the hypotheses. In this study, three null hypotheses were tested for significance level at 0.05 margin of error. The results of the study were presented in tables below.

**Table 1 : ANOVA in which the attitude of respondents towards Physics against the involvement of their parents.**

Variable Entered	SS	df	MS	F	Significant <0.05
Between Group	24784.975	2	13768.756	268.876	*0.012
Within Group	22679.545	377	39.745		
Total	50464.520	399			

\*Significant

In order to ascertain contributing factors of each of the independent variable to dependent variable, analysis of variance was computed. The results that are presented in the table 1 shows that there is a significant relationship between student's attitude towards performance of physics and their parental involvement (p=0.012). So, the student's attitude towards performance of physics have impact on their parental involvement. Therefore, the null hypothesis is rejected while alternate hypothesis is accepted.

**Table 2: ANOVA in which the attitude of respondents towards Chemistry against the involvement of their parents.**

Variable Entered	SS	df	MS	F	Significant <0.05
Between Group	39456.378	2	18647.673	236.942	*0.026
Within Group	41397.951	377	81.785		
Total	80854.329	399			

\*Significant

In order to ascertain the contributing factors of each of the independent variables to the dependent variables, coefficient of correlation was computed. Evidence from the table 2 above shows that, there is a significant relationship between student's attitude towards performance of chemistry and their parental involvement ( $p=0.026$ ). So, the student's attitude towards performance of chemistry have impact on their parental involvement. Therefore, the null hypothesis is rejected while alternate hypothesis is accepted.

**Table 3 : ANOVA in which the performance of Physics against the involvement of their parents**

Variable Entered	SS	df	MS	F	Significant <0.05
Between Group	10376.412	2	6526.752	39.758	*0.019
Within Group	19847.219	377	152.856		
Total	30223.631	399			

\* Significant

In order to ascertain the contributing factors of each of the independent variable to the dependent variables, analysis of variance was computed. Evidence from the table 3 shows that there is a significant relationship between performance of physics and their parental involvement ( $p=0.019$ ). So, the student's performances of physics have impact on their parental involvement. Therefore, the null hypothesis is rejected while alternate hypothesis is accepted.

**Table 4 : ANOVA in which the performance of Chemistry against the involvement of their parents**

Variable Entered	SS	df	MS	F	Significant <0.05
Between Group	18312.874	2	9756.825	121.747	*0.031
Within Group	37421.371	377	71.743		
Total	55734.245	399			

\* Not Significant

In order to ascertain the contributing factors of each of the independent variable to the dependent variables, analysis of variance was computed. Evidence from the table 4 shows that there is a significant relationship between performance of chemistry and their parental involvement ( $p=0.031$ ). So, the student's performance of chemistry has impact on their parental involvement. Therefore, the null hypothesis is rejected while alternate hypothesis is accepted.

**Table 5 :Inter-correlation test between students' attitude and their academic performance in Physics and Chemistry,  $p < 0.05$ ,  $r$  =Co-efficient of Correlation,  $R^2$  = Coefficient of Determination.**

Variable	Correlation of Co-efficient Matrix ( r )					
	Performance of Physics			Performance of Chemistry		
	r	R2	Significant < 0.05	r	R2	Significant < 0.05
Student's						
Attitude	0.664	0.440	0.013	0.537	0.288	0.019

Table 5 shows that, test done to see the relationship between attitude and performance of the two subjects. The correlation of coefficient between attitude and performance (physics and chemistry) are 0.66 and 0.53 respectively. By this, though there is a strong positively correlation between attitude of the students and two science subject. But also the significant relationship with these two variables ( $p=0.013$  and  $0.019$  respectively). So the hypotheses H3 was rejected while alternate hypothesis is accepted. The deciding factor levels for the correlation between attitude and two subjects are 44.0% ( $R^2=0.440$ ), and 28.8% ( $R^2=0.288$ ) respectively. Accordingly, the external factors that do not decide the correlation are 66.0%, and 71.2% respectively.

## VII. DISCUSSION AND CONCLUSION

The phenomena as revealed the tables of results are discussed below. In table 1 and 2 there was a significant relationship between in the attitude of students towards physics and chemistry with respect to their parental involvement. This is in line with findings of Aghanta, 1982 ; Willms, (1986) ; Oluwature, (2009) who believe that an effective collaboration between parent teachers and the community will effectively remove hostility towards schoolwork, motivate children to learn science by way of enhancing their home and school learning environments. Olatoye and Ogunkola, (2008) was also in support of the fact influence of parental involvement enhances achievement in science.

In table 3 and 4, it was also observed that, there was a significant relationship between in the performance of students in the two subjects with respect to their parental

involvement. In other words, the null hypothesis was rejected, at 0.05 level of significance. The fact that there is a significant relationship between the attitude and performance of students due to parental involvement is supported by Sukon and Jawahir who (2005) who observed that home related factors affects numeracy performance. They also confirmed that level of education of parents, availability of reading materials at home, home possession, parental support in education, familiarity with English at home are major factors causing variation in students achievement.

In addition, there was a high level of dependence between attitude and performance among the learners. This was supported by Stelios et.al., 2007 who found out in their study that there was a meaningful relationship between students' attitudes towards science and their science achievement. Parents, irrespective of their economic status would want their children to succeed in school learning and want their children to take up career that will enhance their placement in the future. The outcome of this research work revealed that this expectation might not materialize. The impact of parental involvement on attitude and performance was observed that students with high parental involvement had the highest means in both attitude and performance scores for both physics and chemistry. The next highest set out mean scores belong to those students with average parental involvement except chemistry performance in which the mean score for the average group was slightly than the mean for the high parental involvement group. The lowest set of means score belong to the students from parents with low involvement. This pattern of results implies that the higher the involvement of parents the better the attitude of students towards science and the higher the academic success of such students in science. This research outcome is corroborated by Olatoye and Ogunkola, (2008).

In conclusion, a greater academic progress can be achieved by students if their parents becomes conscious of the fact that there is a lot they can do to bring to reality their goals and aspiration for their children. Indeed the type attitude and performance in science subjects is a function of the level of parental involvement.

## IX. RECOMMENDATION

In view of the importance of parental involvement to academic progress, it is important that school authorities should seek for means of ensuring that the attitude of parent and guidance are influenced positively towards assisting

the students, so that they in turn can put in their best into their school work. Also, parents and teachers should be made to realize the importance of science learning to the individual (that is, scientific literacy) and to the society (technological advancement). School authorities need to organize programs that will bring about parents, teachers and student interaction. This will create a forum for discussion. In this manner, parent will know what they are expected to do to complement teachers' efforts. Schools also need to make such programmes attractive to parents.

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# A SMALL-SCALE GENRE ANALYSIS STUDY OF THE INTRODUCTIONS OF A CORPUS OF POSTGRADUATE ESSAYS IN THE FIELD OF APPLIED LINGUISTICS

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**Abstract** - Most English for Academic Purposes (EAP) courses focus on developing general academic writing skills. Swales (1990) argues that prominence should be given not only to the general writing skills but also to discipline related specific skills in such study courses. Therefore, it is necessary to identify EAP and English for Specific Purposes (ESP) skills that students need to master. The present study analysed a corpus of 19 essays focusing on their introductions in order to identify both EAP and ESP features involved in writing assignment. Swales' (1990) CARS model was applied to analyse the features in these introductions. The findings reveal that the introductions in this corpus closely follow CARS model with some of the Steps described in the model receiving prominence in these essay introductions. The findings also reveal that the students in this study module need to master EAP skills as well as ESP skills, relating relevant discipline specific contexts into writing and using discipline specific terminology in order to produce successful writing assignments. Thus, it is suggested to incorporate both EAP and ESP features in pre-sessional and/or in-sessional courses aimed at students who take similar courses of study.

**Keywords** - ESP, EAP, Genre, introduction

## I. INTRODUCTION

Academic writing is considered the most important language skill necessary for university studies and thus most EAP courses focus on developing academic writing (de Chazal, 2014; Bruce, 2011, p.10;). However, the features that are attempted to address in these courses are mostly general skills (Swales & Feak, 2012, Gimenez, 2008; Brennan, 1995; Hossain, Kummer & O'Leary, 2015) even though they are unique and complex (English, 2011, p.12; Greethem, 2013, p.01; Nesi and Gardner, 2012; Neville, 2009; Redman, 2006 and Andrew, 2003). Swales (1990) argues that prominence should be given not only to the general writing skills that students need to develop but also discipline related specific skills in such study courses. Therefore, incorporating specific features of EAP (Flowerdew and Peacock, 2001, p.8; Jordon, 1997, p.1 & Hyland, 2006, p.1; Benesch, 2001) and academic discipline based features focusing ESP (Hutchinson and Waters, 1989; Munby, 1978; McDonough, 1984; Halliday et al, 1964; Wells, 1992; Hyland, 2011) in the study courses are required.

Genre analysis studies are used to analyse such discipline specific features in academic writing. This paper reports a study that analysed a corpus of 19 postgraduate essays in linguistics to identify the specific features in the introduction of those essays (see Tardy, 2011; Bhatia 1993 & 2008; Hyland, 2008)

The paper contains a literature review, methodology applied in the study, results, discussion and a conclusion

## II. LITERATURE REVIEW

Genre analysis of academic texts and the relevant researches can provide instruments and tools to identify the specific features of any discourse community and the same can lead to identify the specific needs of the academic discipline determined by the discourse community (de Chazal, 2014, p.22; Swales, 1989; 1990 and 2004; Bizzell, 1982; Faigley and Hansen, 1985).

The ESP school approach to genre analysis was initiated with the work of Swales (1990) and Bhatia (1993), and the main focus of this school is how to develop effective pedagogical approach based on the genre analysis. Moreover, genre analysis in ESP is based on the texts and their properties and purposes which are determined by the relevant discourse community. These communicative purposes are revealed by certain steps and moves (Flowerdew 2011b, p.121) in the texts produced in the discipline.

Swales (1990, pp.110-176) analyses the structure of the Research Article (RA), introducing the mechanisms for constructing the introduction, body and conclusion based on important moves. Here, the essays produced in postgraduate courses are also categorised under RAs. Thus, for this research Swales' approach is considered key because it provides a good basis to analyse essays since it is applied extensively in many researches (see. Ahamad and Yusof, 2012; Samraj, 2005; Ozturk, 2007; Hirano, 2009; Loi, 2010; Sheldon, 2011; Anthony, 1999)

Swales (1990, pp.137-138) points out that introductions in RAs are problematic, and it is a difficult venture to create an introduction which leads to continuation of ideas. Swales (1990, pp.138-140) identifies Zappan's adapted approach based on Toulmin's argument (Zappan, 1983 & Toulmin, 1972, as cited in Swales, 1990, p.138) as a "possible approach ... to view RA introductions as encapsulated problem-solution text." Further, Swales analyses Zappan's approach of five rhetorical categories: Goal, Current Capacity, Problem, Solution and Criteria of Evaluation to see the possibility of adapting that to review RA introductions. By citing Smith (1987 as cited in Swales, 1990, p.140) he argues that the credibility of Zappan's approach is questionable since some RAs are not based on problems, or some are only based on observations initiating many problems.

Modifying Zappan's approach, Swales (1990, pp.140-166) creates Create A Research Space model (CARS) (Figure 1), This consists of different features observed in different sections in the RA. For the purpose of this study, the features related to introductions are discussed. CARS identifies that the introduction of RA consists of three major rhetorical Moves (M): "1. Establishing a territory," "2. Establishing a niche," and "3. Occupying the niche." Further, he distinguishes many supportive Steps (S) in each move. As Tardy (2011, p.148) mentions, Swales' findings are significant since the Move-Step approach is more rhetorical than grammatical which indicates "an important departure from text feature analysis."

- Move 1 Establishing a territory
  - Step 1 Claiming centrality and/or
  - Step 2 Making topic generalization and/or
  - Step 3 Reviewing items of previous research
- Move 2 Establishing a niche
  - Step 1A Counter-claiming or
  - Step 1B Indicating a gap generalization or
  - Step 1C Question-raising or
  - Step 1D Continuing a tradition
- Move 3 Occupying the niche
  - Step 1A Outlining purposes or
  - Step 1B Announcing present research
  - Step 2 Announcing principal findings
  - Step 3 Indicating RA structure

**Figure 1. A CARS model for article introductions. Adapted from Genre Analysis English in academic and research settings (p.141), by J. M. Swales, 1990, Cambridge: Cambridge University Press.**

Based on empirical research findings that highlight that introductions in certain disciplines deviate from CARS model (E.g. Samraj, 2001), Swales (2004) proposes modifications to the original model (Figure 2).

- Move 1 Establishing a territory (citations required)
  - Via
  - Topic generalisations of increasing specificity
- Move 2 Establishing a niche (citations possible)
  - via
  - Step 1A Indicating a gap or
  - Step 1B Adding to what is known
  - Step 2 (optional) Presenting positive justification
- Move 3 Presenting the present work (citations possible)
  - Step 1 (obligatory) Announcing present research descriptively and/or purposively
  - Step 2 (optional) Presenting RQs or hypotheses
  - Step 3 (optional) Definitional clarifications
  - Step 4 (optional) Summarising methods
  - Step 5 (PISR) Announcing principal outcomes
  - Step 6 (PISR) Stating the value of the present research
  - Step 7 (PISR) Outlining the structure of the paper

**Figure 2. A revised CARS model. Adapted from Research Genres (p.230, 231), by J. M. Swales, 2004, Cambridge: Cambridge University Press.**

For the purpose of this paper, analysis is done based on only the first Move i.e. establishing a territory.

### III. METHODOLOGY

#### Context

The genre selected to be analysed in this study was from linguistics discipline. The research was conducted based on assignments written by MA in ELT students at the Centre of Applied Linguistics (CAL) of the University of Warwick, UK. At CAL, under six postgraduate degree programmes, 24 study modules are conducted. Various types of assignments are given in each of these modules, and in 23 modules, written essays are considered the main mode of assessments. The maximum word limit of these essays is 2000 to 3000 words according to the course credits of the module. For the purpose of this study, essays written in ET965 Issues and Research in ELT of MA in ELT in 2015 module were selected. The 19 essays used in this study have received more than 50 marks (pass) and thus considered suitable for the study.

#### Analysis

The essays were first analysed to identify if they contained an introduction and the space devoted to the introduction if available. Then the introductions were analysed based on the sentences to identify the occurrence of CARS' first move: Establishing a territory. If it was noticed, further analysis was done to find out whether the Steps of the Move were available.

### IV. RESULTS

#### Availability of an introduction

All the essays contain an introduction and out of them, 17 have labelled it. Out of the labelled essays, 16 have labelled it as 'Introduction' and the remaining one has the title 'Teaching Context' instead of 'Introduction.' The mean word count of the introduction of this corpus is 278.52.

#### Moves and steps

The first Move of the CARS: Establishing a Territory has three Steps, and Table 1 shows the Steps contained in the introductions of the nineteen essays. The three Steps are

shown in the S1 (Claiming centrality), S2 (Making topic generalisation) and S3 (Reviewing items of previous research) columns respectively, and the essay codes are shown in nineteen rows. If a step occurs in the introduction, it is indicated with 'yes' in the relevant box. Accordingly, 13 introductions have the first Step of Move 1. Nine introductions have Step 2, and 14 introductions have Step 3. Essays B, L, N and S contain all three steps of Move 1. Essays A, D, E, H, Q and R contain only one step.

**Table 1: Occurrence of steps in Move 1**

Essay code	S1	S2	S3
<b>A</b>		1	
<b>B</b>	1	1	1
<b>C</b>		1	1
<b>D</b>			1
<b>E</b>	1		
<b>F</b>	1		1
<b>G</b>	1	1	
<b>H</b>	1		
<b>I</b>		1	1
<b>J</b>	1		1
<b>K</b>	1		1
<b>L</b>	1	1	2
<b>M</b>	0	1	7
<b>N</b>	2	1	2
<b>O</b>	2		2
<b>P</b>	1		1
<b>Q</b>			1
<b>R</b>		1	
<b>S</b>	1	1	3
<b>Total</b>	14	10	25

Table 2 presents the number of Steps occurred in each introduction of the 19 essays. Accordingly, Step 3 of M1 has the highest number of occurrences (25).

**Table 2: Number of occurrence of Steps**

No	Essay	S1	S2	S3
1	<b>A</b>	no	yes	no
2	<b>B</b>	yes	yes	yes
3	<b>C</b>	no	yes	yes
4	<b>D</b>	no	no	yes
5	<b>E</b>	yes	no	no
6	<b>F</b>	yes	no	yes
7	<b>G</b>	yes	yes	no
8	<b>H</b>	yes	no	no
9	<b>I</b>	no	yes	yes
10	<b>J</b>	yes	no	yes
11	<b>K</b>	yes	no	yes
12	<b>L</b>	yes	yes	yes
13	<b>M</b>	yes	no	yes
14	<b>N</b>	yes	yes	yes
15	<b>O</b>	yes	no	yes
16	<b>P</b>	yes	no	yes
17	<b>Q</b>	no	no	yes
18	<b>R</b>	no	yes	no
19	<b>S</b>	yes	yes	yes

**Sentences**

In the 19 introductions, 87 sentences occurred in M1 total. Among them, 35 were S1, 15 were S2 and 37 were S3.

**V. DISCUSSION**

**Step 1 Move 1**

Swales (1990, p.144) elaborates the specific functions of Step 1 of Move 1 as ‘Claiming Centrality’ which is maintained based on ‘claim[ing] [an] interest or importance,’ referring to ‘classic, central character of the issue’ or presenting a claim based on prominent findings. He further explains that Step 1 of Move 1 occurs in many academic disciplines, but in some academic fields such as ‘Physical Sciences’, Step 1 is marginalized. In this study, Step 1 of Move 1 occurs in 12 essays out of the 19 essays. Therefore, the percentage of the occurrence of Step 1 of Move 1 is 63.16%. Further, 35 sentences in total are used in Step 1 of the Move 1 in the 19 introductions. Compared to the overall 186 sentences of the 19 introductions, the percentage of sentences occur in Step 1 of Move 1 is 18.81%,

which is the second highest percentage of sentences for a Step. This finding reveals that students’ ability to claim centrality in the introduction is a prominent feature in this academic discipline.

Considering the two definitions of EAP and ESP provided in the literature review, the ability to claiming centrality can be identified as an EAP feature because it is relevant to many academic disciplines. However, the ability to select appropriate theoretical explanations from the available literature in the particular discipline in order to claim centrality can be identified as an ESP feature. For example, in this essay, how an ELT issue is created, and on what basis ELT issues are created should be analysed based on the accepted norms of the ELT discourse community. Moreover, the terminology should be discipline specific to address the ELT discourse community to achieve the communicative purpose: claiming centrality. Thus, both EAP and ESP features can be observed in these introductions when claiming centrality.

**Step 2 Move 1**

Swales (1990, pp.146-148) shows that Step 2 of Move 1 presents a ‘general statement’ without being bias to any theory or practice since its function is to make the topic generalized. Hence, accordingly to Swales (1990, p.146), Step 2 of Move 1 consists of statements of general facts based on ‘knowledge, practice or phenomena,’ and these statements ‘express in general terms the current state of the art – of knowledge, of technique ... of current requirements for further progress.’ Moreover, Swales (1990, pp. 146-147) emphasizes that Step 2 of Move 1 shows ‘strong tendency for Phenomena’ to generalize the topic in order to accomplish the Move 1 objective: establishing a territory. Research findings of this study show that Step 2 of Move 1 occurs in 9 essays out of the 19 essays, and the percentage of occurrence of Step 2 of Move 1 in the introductions of the corpus is 47.37%. Furthermore, 15 sentences are utilized for Step 2 of Move 1 of the 19 introductions with a percentage of 8.06%. The data analysis shows that the 15 sentences in Step 2 of Move 1 express general statements constructed based on claims of the authors’ experience, common beliefs or some phenomena. Following two examples show these features. First sentence explains the effectiveness of collaborative action researches based on solving problems and encouraging the progress of professional practice. Any scientific proofs on how collaborative researches achieve these statuses is not given, but only author’s view is presented. Second sentence contains a phenomenon as

“... learner autonomy is an influential factor...” Further, the phenomenon is justified by creating a rationale which is not developed based on objective description. The rationale may be based on previous knowledge or what author learnt in practice.

- a. Collaborative action research works as an effective approach not only to solve practical teaching problems but also to promote in-service teachers’ personal and professional development worldwide. (Essay A)
- b. In an EFL context, learner autonomy is an influential factor because students do not have enough opportunity to encounter authentic English communication outside the classroom... (Essay B)

The analysis shows that Step 2 of the Move 1 is mainly based on phenomena or general statements to make the topic generalized. Explaining a phenomenon of general statements based on common knowledge of the academic discipline is relevant to every academic discipline; therefore, generalizing a topic should be more relevant to EAP rather than ESP. However, relating it to the specific discipline and using discipline specific terminology can be features of ESP.

### Step 3 Move 1

Research findings of this study shows that Step 3 of Move 1 occurs in 14 essays out of the 19 essays, and the percentage of occurrence is 73.68%. Furthermore, 37 sentences are used for this Step and percentage of sentences is 19.89%. This shows a higher occurrence of this Step in the corpus.

Function of Step 3 of Move 1 is “reviewing items of previous research”. Swales (1990, pp. 148-154) explains that Step 3 of Move 1 is for sharing information related to other researches focusing on ...who has found what... This step has a higher level of occurrence across many academic disciplines. Therefore, many relevant skills and appropriate knowledge are required to successfully develop sentences relevant Step 3 of Move 1 in any academic article. Thus, this Step contains EAP features. Swales (1990) discusses some salient features identified in this Step: one of such features is the tenses used in in-text citations. In-text citations are practiced in many academic disciplines; therefore, how English language features are used in proper in-text citations based on the accepted referencing system is directly relevant to EAP.

Although EAP is involved in dealing with the linguistic mechanisms of referencing, ESP aspects are also involved

in this Step. For example, identifying specific aspects of the previous researches relevant to ELT in these essays is based on subject specific knowledge, and only English language skills accepted by the ELT discourse community should be utilized to identify the relevant features of the previous researches. In this regard, relevant terminology and the subject specific practices are also crucial. Therefore, proficiency in ESP relevant to ELT is required to develop appropriate sentences to review previous research.

## VI. CONCLUSION

The study discussed in this dissertation attempted to analyse the specific features in postgraduate essay introductions in the study module ET 965 Issues and Research in ELT of MA in ELT at Warwick University. In order to analyse the introductions, Swales’ (1990) CARS model was used although the model was original proposed to be used to analyse research articles.

The study findings revealed that the majority of the essays have introductions and the first move of the CARS: Establishing a territory occurs in all the essays in the corpus. The findings also indicate that Step 3 is the most prominent step in the move one. That indicates “reviewing items of previous research” more important in essay writing of the selected academic discipline. .

The study also reveals that the Steps that occurred most have both EAP and ESP features and thus the students in this module should have both EAP and ESP skills in order to write successful essays in this study module. In particular, ESP skills such as selecting appropriate literature from the available literature in the specific discipline, identifying trends and issues in the particular field and the ability to use technical jargon in writing are some of the ESP skills that have been observed in these introductions. Summarising, topic generalisation, in-text citations and counter claiming are some of the EAP features observed in the corpus. Therefore, it is necessary to focus on both EAP and ESP features when designing pre-sessional and/or in-sessional courses for students who are going to take this linguistic module.

The study has also several limitations. One is that the corpus is small and thus more research with more samples may be necessary to generalise the results obtained in this study. Moreover, statistical analysis may be necessary in order to come to conclusions based on the data obtained. This study only analysed the introductions of the essays in the corpus and thus the findings may be insufficient to

come to a conclusion on what EAP and ESP features are prominent in essays in this particular module. In depth analysis of the other sections of the essays is necessary to identify the other features.

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# UNIVERSITY LEARNERS' PERFORMANCE IN USING THE DEFINITE ARTICLE IN DEFINITE CONTEXTS VERSUS THE INDEFINITE ARTICLE IN INDEFINITE CONTEXTS.

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**Abstract** - Interlanguage errors have long been a field of interest for a number of studies over the years. Errors in article usage, a kind of interlanguage errors are a persistent problem that teachers of English as a second/foreign language very often encounter. It is widely observed in the Sri Lankan context too that learners have difficulty with the article system of English as Sri Lankans consider error-free English as the hallmark of English proficiency. Many teachers agree that errors in article usage is basically a problem caused by the absolute complexity of English article system as learners experience difficulty in expressing definiteness or indefiniteness of the noun using appropriate articles. This study was an attempt to identify whether the first year undergraduates at the Wayamba University of Sri Lanka performed better in using the definite article in definite contexts than the indefinite article in indefinite contexts. The study was carried out by means of a pre-test, a post-test and a delayed post-test. Teaching was done after the pre-test and the post-test was deployed after teaching and a delayed post-test was conducted four weeks after the post-test. The tests consisted of a cloze test and a free writing task. The necessary data were obtained by analysing the students' errors in zero, single and multiple modifier noun configurations. The descriptive method was used and a statistical analysis was followed to identify the variance of errors. P values of two-way ANOVA tests on the percentages of correct attempts were

considered to determine the effect of article type on the learners' performance. The analysis of the results indicated that the article type had some significant bearing on the performance of the subjects' using of articles, and they performed better in definite contexts than in indefinite contexts. This supports the view that learners have to be exposed to a considerable amount of language over a long period of time before they master certain grammar rules, especially articles, which consist of a number of rules as well as exceptions to those rules.

**Keywords** - interlanguage, errors, grammar

## 1. INTRODUCTION

The rationale behind this study is to identify in which type of article usage the students of English as a second language (ESL / L2) commit less errors. The comparison was twofold; a comparison of the performance between the definite article ('the') and the indefinite article ('a and an') and a comparison among three articles ('a', 'an' and 'the'). First comparison is to find out whether the students perform better in definite contexts than in indefinite contexts and the second comparison is to identify the article which the students control best.

Since the relevant literature indicates that many



researchers have approached articles from different perspectives such as error analysis, acquisition of the second language, semantics and pragmatics (Agnihotri, Khanna, & Mukherjee, 1994; Robertson, 2000; Trenkic, 2007; Zdorenko & Paradis, 2008; Snape & Kupisch, 2010), the present study too is based on an error analysis, which seems to be the most extensively followed practice among the researchers who carried out studies on articles.

## 2. METHODOLOGY AND EXPERIMENTAL DESIGN

The corpus of the language sample was studied for errors in article usage by identification, categorization and explanation, which was suggested by Corder (1973) and later modified by Brown (1994), Ellis (1997) and Gass and Selinker (2001). This was a widely-held and frequently utilized method in carrying out an error analysis. Data were collected by means of three tests (a pre-test, a post test and a delayed post-test). Each test comprised two tasks; a cloze task and a free writing task; the cloze task was based on reading and writing skills and was intended for the purpose of testing the key uses of articles while the free writing task was based on writing skills for the purpose of identifying whether types of errors committed in the cloze task could be observed in their written production too. Two different tasks were chosen as the relevant literature indicates that students' performance is affected by the task they are engaged in (Agnihotri et al., 1994; Robertson, 2000; Trenkic, 2007; Zdorenko and Paradis, 2008; Snape and Kupisch, 2010). Since students were not informed that article usage would be tested in their free writing task, it is assumed that they produced articles involuntarily. However, in the cloze task (forced choice elicitation task) students had to produce articles consciously.

The present study used a description of an imaginary local person given in about 197 words. It was adapted and modified from a task given by Hewings (2002) in his Advanced English Grammar textbook. The advantage of this task was that it provided a high degree of control over the input. The same cloze task was used in all three tests (pre-test, post-test and delayed post-test). In this particular cloze task participants had to supply 27 missing articles (ten blanks for missing 'the', eight blanks for missing 'a' and another nine blanks for missing 'an').

The free writing task was for them to write a short description in about 200 words on the topics 'The most unforgettable day', 'The most unforgettable person' and 'The most unforgettable teacher'. Although the same cloze

task was used in all three tests, the participants were given a different topic for the free writing task in each test. Although the original study focused on a number of analyses, this particular analysis was done to determine whether the students perform better in definite contexts than in indefinite contexts. For the purpose of this particular analysis the performance in each type of article was considered separately. Therefore, for this analysis the subjects' performance in the usage of three main articles ('a', 'an' and 'the') in the cloze task and the free writing task was compared across the three tests conducted. Zero modifier, single modifier and multiple modifier noun configurations of three main articles (See Table 1 for the examples for these configurations) were considered in order to determine the variance among them in this particular analysis.

Then the errors were identified and classified based on the noun phrases in which the articles were used. Finally, the quantification and description were carried out to complete the error analysis process.

In the present study, after the pre-test a two-hour lesson on articles was given to the participants by a lecturer in ELT. Then after a week's time the post-test was administered and the delayed post test was conducted ten weeks after the pre-test. Subjects were given 40 minutes to complete the cloze task as well as the free writing task. The cloze task was printed on one side of an A4 paper and the instructions for the free writing task were printed on the other side (Appendix i sets out the sample of the cloze test). Although it was planned to administer the tests to 60 subjects, only 48 were present for the pre-test, 44 for the lesson on articles, 38 for the post-test and 39 for the delayed post-test.

**Table 1: Noun configurations used in the present study**

Article Type	Configuration	Example
the	1. the + noun	the manager
	2. the + single modifier + noun	the Colombo branch
	3. the + multiple modifiers + noun	the most skilful player
a	1. a + noun	a member
	2. a + single modifier + noun	a professional cricketer
	3. a + multiple modifiers + noun	a leading political party
an	1. an + noun	an umbrella
	2. an + single modifier + noun	an honest person
	3. an + multiple modifiers + noun	an ambitious branch manager

## 2.1. Sample

The sample consisted of first year undergraduates of the Faculty of Applied Sciences of the Wayamba University of Sri Lanka. This particular faculty is one of the four faculties of the university and students who take combined mathematics for the General Certificate of Education - Advanced Level (G.C.E. A/L) are selected for its study programmes.

## 2.2. Collection of Data

The test was administered in the classroom where the participants usually had their English classes. No special seating arrangement was made and the printed test paper was distributed among them. They were given 40 minutes to complete both tasks. These 40 minutes were taken at the beginning of their usual two-hour class. Two tasks of the test were printed separately on each side and they were expected to fill in the blanks with 'a', 'an' or 'the' for the cloze task and write the given description in the space provided for the writing task.

## 2.3. Analysis of Data

The procedure followed by Agnihotri et al. (1994) in their study for data analysis was adopted in the present study too. They presented data based on percentages and the method they used to calculate the percentage of correct attempts was adopted in the present study since it was a simple, straightforward method which helped comprehend data easily. The procedure was to calculate the total number of attempts that could be made for each potential place in each noun configuration of the cloze task. The percentage of correct responses was calculated against the total numbers of attempts. For example, there were six potential places in the cloze passage where the definite article was required to be inserted in 'the + noun' configuration. Since the total number of subjects being 48 at the pre-test, then the total number of attempts would be calculated as 288 ( $48 \times 6 = 288$ ). Out of these, 'the' was correctly inserted only in 113 attempts. Thus 39.24% ( $113/288 \times 100$ ) responses were correct.

In the free writing task, all possible noun configurations were marked separately and the total number of attempts representing one configuration was calculated by considering all the essays produced by the participants. When essays were analysed for the errors in article usage, individual scripts were considered and the total number

of noun phrases requiring articles was identified. After that the number of correct inclusions of articles in these noun phrases was also identified. Both article omission errors as well as article misuse errors were taken into account during the analysis. Likewise, all the scripts were evaluated and the percentage of correct responses was calculated for each article configuration. For example, there were 167 potential places in all the 48 essays where the definite article is required to be used in 'the + noun' configuration in the pre-test. Therefore, the total number of attempts is 167. Out of them only in 78 attempts 'the' is correctly inserted. Thus 46.71% ( $78/167 \times 100$ ) responses were correct. Likewise, calculations for all the noun configurations were carried out. When analysing the errors of article usage in the free writing task, the length of the essays produced was not taken into consideration. The number of errors in each noun configuration was noted and percentages of the correct use were calculated. The same procedure was repeated in all three tests.

## 3. ANALYSIS AND INTERPRETATION OF DATA

All possible configurations were considered for the analysis as the relevant literature indicates that an article can precede a noun with or without modifiers. The 'article + zero modifier + noun' configuration was considered when no modifier was used to modify the noun (e.g. the manager). The 'article + single modifier + noun' configuration was considered when only one modifier was used to modify the noun (e.g. the Colombo branch). The 'article + multiple modifiers + noun' configuration was considered when two or more modifiers were used to modify the noun (e.g. the most skilful player, the best supporting actor award). Therefore, articles used in the tasks (the cloze task and the free writing task) were coded according to the noun configurations as correct use of 'the', 'a', and 'an' in 'article + noun', 'article + single modifier + noun' and 'article + multiple modifiers + noun' configurations. Both tasks were marked on the basis of the correct or incorrect article used in the noun configurations given in Table 1.

### 3.1. Articles in zero modifier noun configurations

The analysis of the above configuration shows that the subjects' performance in 'an + noun' configuration is higher than their performance in other configurations. But their performance in 'the + noun' and 'a + noun'

configurations is more or less the same. The results of the ANOVA showed that there was some significant variance among noun configurations as P values for configurations were 0.027 ( $P < 0.05$ ), 0.035 ( $P < 0.05$ ) and 0.022 ( $P < 0.05$ ) for the pre-test, post-test and the delayed post-test respectively. In other words, they indicate that the changes in noun configurations affect the performance of the students' use of articles.

### 3.2. Articles in single modifier noun configurations

When analysis of the above configuration is concerned, it is clearly visible that the subjects' performance in the 'an + single modifier + noun' configuration is the highest when compared with the other two configurations in both tasks of all the tests conducted. It also confirms that subjects perform better in noun configurations of 'an' than the other two. The results of the ANOVA in this context showed that there was some substantial variance among configurations as P values for noun configurations in the cloze task and the free writing task were 0.007 ( $P < 0.05$ ), 0.018 ( $P < 0.05$ ) and 0.046 ( $P < 0.05$ ) for the pre-test, post-test and the delayed post-test respectively. Once again it restates the fact that the change in noun configurations affects the performance of the subjects' use of articles.

### 3.3. Articles in multiple modifier noun configurations

The results shown in the above configuration are also similar to the ones obtained for the previous contexts. Here also it indicates that subjects' performance in noun configurations of 'an' is better than in the other two configurations. The results of the ANOVA for this configuration showed that there was some noteworthy variance among configurations as P values for configurations in the cloze task and the free writing task were 0.042 ( $P < 0.05$ ), 0.031 ( $P < 0.05$ ) and 0.041 ( $P < 0.05$ ) for the pre-test, post-test and the delayed post-test respectively. It confirms the results obtained for the zero modifier and single modifier noun configurations. So it can be concluded that subjects' performance is affected by the noun configuration in which the article is placed.

When the subjects' performance of the definite article is considered against their performance of the indefinite article ('a' and 'an' together), Figure 1 shows that the subjects' performance is slightly higher in the definite article than their performance in the indefinite article. Figure 2 shows that the subjects' best performance was reported in noun configurations in which the indefinite article 'an' is placed, their worst performance was reported in noun configurations in which the indefinite article 'a' is

placed. This result supports what Pica (1983), Robertson (2000) and Trenkic (2007) have found in their studies.

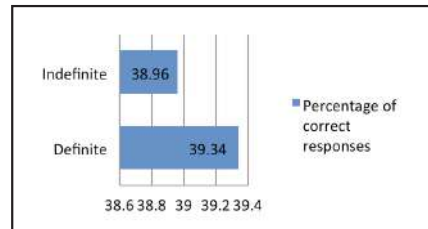


Figure 1: Overall performance of definite and indefinite articles

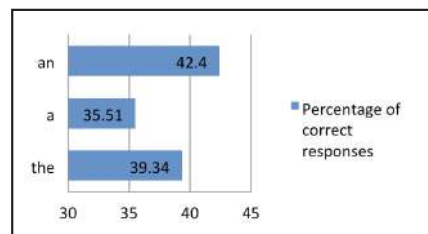


Figure 2: Overall performance of each article

## 4. DISCUSSION

This study too confirms that the article system of English can pose problems for ESL learners as the data show a lot of variability in these students' interlanguage. In addition, this investigation is notable among the studies based on article usage by ESL learners as articles used in different noun configurations are given more prominence and compared in three tiers; tests, tasks and configurations. It is rare to find studies which attempt to analyse the data across a broad range of comparisons. Although their performance in using indefinite article 'an' was the highest when individual articles were concerned, the overall performance of using the definite article in definite contexts was better than their usage of the indefinite article in indefinite contexts. Since the analyses of the present research were based on all possible comparisons, they further consolidated the findings of the previous studies in a broader setting.

### 4.1. Limitations of the Research

It is imperative to consider some of the limitations of the study carried out. The main concern with regard to the cloze task was that it was not possible to include all basic

uses of articles as the scope of the uses that the definite and definite articles encompass is vast. In addition, the article uses tested in the cloze task are not a true representation of the items discussed in the lesson. Moreover, the researcher did not have any control over the output of the free writing task as it was a production task. The data yielded just one or two examples of some noun configurations while for others, there was no evidence. Thus when the subjects' performance in these two tasks was compared they might not have fully represented the subjects' ability to manipulate the English article system.

#### 4.2. Future Directions

Although 'missing articles' in obligatory contexts was a frequent occurrence along with incorrect use of articles, in the present study it was also considered under the category of incorrect use of articles, not as a separate phenomenon. However, it is important to identify whether omission of articles is deliberate or unintentional as it is difficult to determine whether the learner has omitted the articles or replaced it with the zero article. One future area of research would be to look into the learners' omission of articles and to identify whether they are intentional or unintentional. Another phenomenon which is worth studying is the use of articles in configurations other than with common nouns. It has been observed that ESL learners tend to use articles in front of words such as verbs, prepositions, pronouns, etc. Although these errors have been disregarded in the present study, the researcher feels that these errors are also prominent in their interlanguage and command attention.

#### 4.3. Conclusions

Although the students' performance in definite contexts is slightly better than in the indefinite contexts, this research also suggests that there is a sequence in the acquisition of articles. 'An' seems to be mastered prior to the other two and 'a' requires more time in comparison with the other two. This particular pattern of variation in the performance on the different types of articles suggests that ESL learners may not acquire all forms of articles simultaneously.

However, these findings indicate that ESL research on articles should be replenished by identifying whether learners' omission of articles is intentional or unintentional as well as the reasons for their using articles in places other than with common nouns.

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**Appendix I – Tests Conducted**

Task 1. Write the missing articles (a, an or the) in the blanks.

Nimal Perera; A profile

Nimal Perera recently became ..... chief minister in a local government institution. Mr. Perera is ..... honest person and has had ..... varied career. He was ..... professional cricketer in ..... 1980s. He used to be .....all-rounder and some people considered him to be ..... most skillful player of his generation. After ..... series of injuries, he became .....manager of ..... Colombo branch of ..... ABC bank. Most of ..... staff considered him to be ..... ambitious branch manager. Nevertheless he was very popular among his colleagues as ..... easy – going character. Later he became ..... actor for ..... brief period of time. He won ..... best supporting actor award for his only film in which he acted as ..... marriage broker who always carried ..... umbrella. Some years later, he was offered ..... executive position in one of ..... biggest supermarket chains in ..... country. After that he became ..... active member of ..... leading political party. The party asked him to contest for the local government election as he was ..... attractive down-to-earth politician. Now he also holds ..... ministerial portfolio there and wants to be .....member of parliament one day.

**Appendix II – Answers for the Task 1**

Nimal Perera; A profile

Nimal Perera recently became the chief minister in a local government institution. Mr. Perera is an honest person and has had a varied career. He was a professional cricketer in the 1980s. He used to be an all-rounder and some people considered him to be the most skilful player of his generation. After a series of injuries, he became the manager of the Colombo branch of the ABC bank. Most of the staff considered him to be an ambitious bank manager. Nevertheless, he was very popular among his colleagues as an easy – going character. Later he became an actor for a brief period of time. He won the best supporting actor award for his only film in which he acted as a marriage broker who always carried an umbrella. Some years later, he was offered an executive position in one of the biggest supermarket chains in the country. After that he became an active member of a leading political party. The party asked him to contest for the local government election as he was an attractive down-to-earth politician. Now he also holds a ministerial portfolio there and wants to be a member of parliament one day.

# THE FACTORS THAT AFFECT THE DEMAND FOR PRIVATE UNIVERSITY EDUCATION IN SRI LANKA.

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competitive with only two percent of students having the opportunity for admission. This situation manipulates a severe competition among students and it gives rise to the establishment of private universities. This establishment creates numerous issues on social and economic aspects. Recently in Sri Lanka, there is an increase in demand on private university degree programs. This study attempts to examine the socio economic factors that can affect the demand for private university education of undergraduates in South Asian Institute of Technology & Medicine and Sri Lankan Institute of Information Technology. This study would help the policy makers to improve the quality of undergraduate education. The sample subjects comprised 150 out of undefined number of undergraduates covering both private and public sector universities in Colombo district and the data were gathered through questionnaires. Contributing elements were identified through extensive review of literature and a preliminary study. Finally an instrument was designed with 29 statements with a 5 point rating scale and open ended questions. Chi-square, Multiple Regression Model, Binary Logistic Regression Model method were utilized to analyze the data. The findings revealed that gender, living sector, parents' educational level, occupation of parents, ethnicity, A/L Stream, A/L attempt, ability to enter to a state university, degree type, specified area of the degree, place of residence and satisfaction of the degree, have a significant impact on undergraduates' education. This study concludes the above socio-economic factors have a significant impact on the demand of private university degree programs.

**Keywords** - private university, demand, undergraduates, socio economic.

## I. INTRODUCTION

At present the demand for private university education remains wide spread complex and global phenomenon. This change in demand is due to different socio economic factors such as religion, education, social status, family background etc. These changes create both advantages as well as problems on university education and economy such as high cost, social conflict and quality reduction of degree programs which are conducted by the government universities in Sri Lanka. The prior researchers are based on "what are the factors that affect to the demand for private universities education". But the researchers conducted in this context in Sri Lanka are limited. Therefore, inspecting on this particular area would be helpful for ongoing researches. Therefore the investigation is important to policy implementation and develop the tertiary education system through government policy making process.

According to the research, Sri Lanka needs more universities and increase the annual intake of students. This is not an easy task for the government, with other priorities in health, transport and infrastructure development etc. Therefore, government face difficulties in investing new state universities.

The quality of the university education vary from country to country. Especially, this is commonly seen in developing countries like Sri Lanka. Private university education will continue to be a part of globalization process and it has created a strong demand in the education system. So that private university education is gradually becoming recognized as a key factor for the growth of university demand.

In this research the main objective is to identify the factors that affect to the demand for private university education in Sri Lanka and specific objectives are, to identify the impact of public and private university education on undergraduates demand and identifying the students' demand differences among public and private sector.

## II. METHODOLOGY

The selected population was the undergraduates who study in public and private sector in four universities in Colombo.

This sampling process was based on the stratified and simple random sampling techniques. The whole population has been divided into sub groups or strata and then selected undergraduates are a proportion out of the total final sample.

150 undergraduates were selected as the sample representing private and public sector. Among them private sector represents 90 undergraduates and public sector represents 60 undergraduates. Among four universities, two universities represent the private sector and other two universities represent the public sector. SLIIT & SAIMT selected as two private universities. Among public sector two universities selected such as Colombo and Jayewardenepura are the two state universities.

## III. DATA ANALYSIS

Multiple regression analyzing method and Binary Logistic regression analyzing methods are used as the analyzing tools in this study.

### Multiple Regressions Analysis Procedure

Multiple Regression model used to analyze the expenditure on private universities degree programs.

$$Y = \beta_0 + \beta_1x_1 + \beta_2x_2 + \dots + \beta_nx_n$$

- Y = Expenditure on private university degree programs.
- $\beta_0$  = Constant or intercept
- $\beta_0 - \beta_1$  = Slope or Coefficient,
- $x_1 - x_n$  = Independent variables that are explaining the variance independent variable.
- $X_1$  = Income,
- $X_2$  = Complementary Expenditure.
- $X_3$  = Transport Cost.
- $X_4$  = Number of Institutions.
- $X_5$  = Ability to Enter Public Sector University.
- $X_6$  = A/L Stream.
- $X_7$  = Living Sector.
- $X_8$  = Gender.
- $X_9$  = Place of the Student in the Family.

### Binary Logistic Analysis Procedure

Binary logistic regression analyzing method is used as two aspects. In first logistic regression analysis, test whether undergraduates engage in a private university. The dependent variable assumed the value 1 for private universities and 0 for government universities.

$$\log \pi = \beta_0 + \beta_1x_1 + \beta_2x_2 + \beta_3x_3 + \dots + \beta_nx_n$$

**Dependent Variable:** University education by Undergraduates

- 0 = No,
- 1 = Yes
- X = ( $X_1, X_2, X_n$ ) are explanatory (independent) variables and linear in the parameters
- $\beta_1, \beta_1$  = Parameters,
- $X_1$  = Income,
- $X_2$  = Complementary expenditure,
- $X_3$  = Transport Cost,
- $X_4$  = Number of institutions,
- $X_5$  = Ability to enter public sector university,
- $X_6$  = Stream.
- $X_7$  = Sector,  $X_8$ =Gender

**Results and Discussion**

According to the findings, demographic factors such as gender, ethnicity, age and living sector have shown considerable variation regarding the demand for private university degree programs. Concerning the gender, among both government university and private university undergraduates 81% and 44% male respectively and 44% and 56% of female respectively. That means female express higher demand for private university degree programs than male. This difference occurs because females have more opportunities, freedom, willingness and higher education opportunities in private universities.

Based on the ethnicity, Sinhala and other ethnic groups like Muslim undergraduates engaged with private university education. As a whole, 98.72% of contribution have been represented by the Sinhala category for private university education while Muslim and Tamil representation for private universities is very low (1.28%) due to their social and cultural barriers, lack of educational opportunities and less preferences.

**Table 1: Factors affect to Expenditure on Private University Degree Programs**

Predictors	P values	Predictors	P values
Constant	.000	University name	.001
University	.000	Degree	.000
Mothers Edu Level	.649	A/L Shy	.351
Fathers Edu Level	.930	Degree Type	.510
A/L Stream	.010	Monthly Expenditure	.041
Z -Score	.003		

Considering p value of the selected variables, University category, A/L Stream, A/L Z-Score, University name, Degree and Monthly Expenditure were significant at 95% confidence level and 5% significant level.

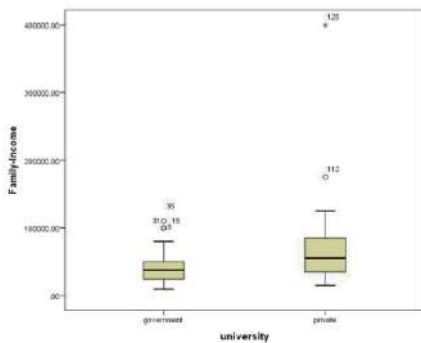
Under the Binary logistics Analysis, five explanatory variables have been studied to check which explanatory variables are associated with demand for private University education.

**Table 2: Factors affect for the University education by Undergraduates**

Variable	P- Value	Conclusion
Age	0.000	There is a relationship between demand for
		private university education and age.
Family Income	0.000	There is a relationship between demand for
		private university education and family income.
A/L Z score	0.000	There is a relationship between demand for
		private university education and A/L Z Score.
Degree fee	0.986	There is no relationship between demand for
		private university education and degree fee.
Monthly Expenditure	0.000	There is a relationship between demand for
		private university education and monthly
		expenditure.



According to the results of Binary logistics analysis, only four explanatory variables were associated with private university education and remaining variable of degree fee did not show a considerable relationship with the response variable



**Figure 1: Sample Distribution of Family Income of the Undergraduate**

According to the above figure it portrays the family income of undergraduates of private and state universities. The high income families are more concerned to render educational needs for their children due to the existence of private universities in Sri Lanka. If there are no private universities in Sri Lanka then outflow of Sri Lankan money into foreign countries would occur. This directly affect to the BOP in Sri Lanka. On the other hand this paves the way to middle income earning groups to participate in higher education. This group does not have a sufficient income to send their children abroad for higher educational needs. But now due to the establishment of private universities it opens the door. This is a positive feedback.

There is a highly considerable difference between private university education and government university education among urban and rural sector. When considering the urban undergraduates, higher portion are in private universities. However, living sector could not be identified as a significant predictor of overall demand for private university education.

Under socio economic profile, education level, monthly family income, employment, monthly expenditure emerged as significance factors with demand for private university education.

There is an excess demand in higher education. This excess demand is caused due to the higher competition among the younger generation. And due to the shortage of government resources to fulfill this uprising demand.

Therefore the government is unable to facilitate free education for all of them. Government is already incurring a huge amount of expenditure on free education. Therefore the government is not in a situation to satisfy all the current requirements. Hence as an alternative the government is trying to promote private universities under the state supervision.

According to the findings it can be observed that there is a trend among the middle income earning family female students those of whom who are already selected to the state universities prefer to enter to private universities. The reason for this fact is they are highly concerned in completing their degree program in a specific period of time. Which is a highlighted feature in private universities. But when it comes to state universities due to external factors such as ragging, boycott, picketing and so on. State universities are unable to proceed the degree program within the relevant period of time. Therefore state universities have to consider this fact and take necessary precautions in order to evade this fact.

According to this situation there is a threat for the state universities. Therefore state universities have to reconsider to develop their courses in order to fulfill the modern job market requirements. And it should develop a severe competition with the private universities. Through this competition it will directly effect to develop the higher education in Sri Lanka.

According to the findings the family income is an important demarcation for high demand in private universities. Families with high income have a stronger performance for private higher education. And families with low income are less motivated. As a solution poor income earning families can be encouraged and motivated by introducing loan schemes and bonds.

## IV. CONCLUSION

In conclusion, the expansion of private university education has been brought about by the ever increasing demand of university education. The heavy burden of government expenditure on higher education demanded the subject of the establishment of private universities. Consequently the free primary education and free secondary school education has led to increased demand for higher education. The absorption capacity of government universities is limited thereby leaving out many intellectual A/L students who are unable to enter

to the state universities due to the limitation of students' intake by the so called Z- score. It is in light of this scenario that the private sector can play a crucial role in the establishment of private universities to fill the gap left by the government universities.

Moreover it can be concluded that the high participation of females in private universities is due to the fact that females have more chances, freedom, willingness and higher education opportunities. In addition in the 21st century females are not willing to be bounded only by domestic chores and also they expect to complete their degrees without a time lag which generates a high demand in higher education. However there are some criticisms that private universities mainly target on profit orientation.

With the establishment of private universities it generates opportunities for not only high income earners but also middle income earners who cannot afford for foreign higher education. Consequently this enables a positive impact on GDP since it prevents the outflow of money into other countries due to the availability of private higher education within the country itself. Moreover, Sri Lanka is reputed for its quality in higher education than other countries such as China, Russia, and Bangladesh and so on. Therefore this also increases the demand for the establishment of private universities in providing quality education.

As per the final conclusion it can be concluded that through the establishment of private universities it creates an efficient competition on the state universities which will lead to inculcate the standard of higher education

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# PRESENTATION AND CORRELATES OF MORAL INJURY AS A RESPONSE TO PAST TRANSGRESSION

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**Abstract** - The concept of moral injury has been researched mostly on military personnel who have either witnessed or engaged in acts generally deemed to be moral transgressions, during combat. Although, it is explored mostly among war veterans, moral injury among non-military personnel who have committed moral transgressions, too, ought to be investigated for the greater good of society. The purpose of this research was to qualitatively explore the presentation and the correlates of moral injury in a non-military prisoner sample, using a working model, postulated by Litz (2009) and his colleagues. Fifteen prisoners who had committed acts of manslaughter or pre-meditated murders presently kept at the Welikada Prison, Colombo Sri Lanka were interviewed. Using the qualitative method helped to explore each step of the model in-depth. The research revealed that despite the sample experiencing cognitive dissonance, they did not progress to Litz's et.al.,(2009) next step; that is 'global, internal' attribution, but they engaged in 'moral justification and externalization' as attribution, which became a prevalent protective factor in the prevention of psychological, social and emotional impairment. According to the model shame and guilt are jointly expected to lead to social withdrawal. However, that was not observed in this sample. Interestingly though the use of the spiritual attribution both to justify and rationalize their actions as well as a mechanism in distress management was observed frequently among the subjects.

**Keywords** - Moral injury, justification, moral transgression, spirituality

## I. INTRODUCTION

The concept and the theory of moral injury are currently used in understanding the mental health of military personnel who have witnessed or engaged in morally transgressing acts in combat operations. Although it is mostly used among war veterans, it is applicable to moral transgressions committed by non-military personnel. There is a scarcity of research on moral injury among non-military populations. Moral injury being a new concept, it has a working conceptual model that was developed by Litz, Stein, Delaney, Lebowitz, Nash, Silva, & Maguen (2009). The intention of the current research was to study the applicability of Litz et al. (2009) working conceptual model in a sample of Sri Lankan prisoners convicted of murder.

Many researchers believe that moral injury is often misdiagnosed to be Post Traumatic Stress Disorder (PTSD) probably because there is similarity in the trigger factors and the symptoms in both cases. However in moral injury, the focus is on the perpetrator, while Post-Traumatic Stress Disorder (PTSD) is focused on the victim; the person who has witnessed or had been exposed to a traumatic event. Furthermore, unlike PTSD being a diagnosable disorder, moral injury is a concept that has still no demarcation for diagnosis.

The concept of moral injury was first defined by Shay (1994) as the psychological consequence of a betrayal of what's right by someone who holds legitimate power in a high-stake situation. According to Litz et al. (2009), "Potentially morally injurious events, such as perpetrating,

failing to prevent, or bearing witness to acts that transgress deeply held moral beliefs and expectations may be deleterious in the long-term, emotionally, psychologically, behaviourally, spiritually, and socially” (p.1). One shared idea in these definitions is that ‘transgression of moral values’ causes emotional, psychological and social effect. Moral injury happens subsequently to a transgression of one’s own moral values. Shay (2002) introduced the idea of ‘high stake situation’. High stake situation’ is defined as a situation that has a lot of risk and in which someone is likely to either get or lose an advantage (Cambridge dictionaries online, 2011). According to Shay’s definition, moral injury happens in a high stake situation where the person is under pressure to make a decision. When we review Litz et al. (2009) definition, it does not talk about the concept of ‘high stake situation’. Shay (2002) described that moral injury takes place due to an act of moral transgression that causes profound emotional shame. What Shay also defines as “moral injury is something that causes psychological distress”. Even though there are slight differences among definitions, it appears that most contain the common idea that moral injury causes damage to the person’s psychological wellbeing and subsequently to the transgression of moral values.

It’s important to review how mental health professionals have tried to make a distinction between Post-traumatic stress disorder (PTSD) and moral injury. Shay (2010) explains Post-traumatic stress disorder as the primary injury, the “uncomplicated injury” and Moral Injury as the infection; it’s the haemorrhaging. Shay(1994) explained that moral injury can happen when there is a betrayal of what’s right by someone who holds legitimate authority in a high-stakes situation. Gibbons-Neff (2015) describes a distressful combat experience of a veteran who was deployed in Afghanistan who had killed a kid and carrying difficult emotions, memories, thoughts even 10 years later. Gibbons-Neff (2015) explains that about ten years ago, above situation could have been diagnosed as post-traumatic stress disorder and sixty years ago, it would have been combat fatigue. According to above example, it appears to be a clear example of how it has affected making the correct diagnosis of mental disorder.

Litz et al. (2009) argue that serious exploration is needed to make a distinction between PTSD and Moral injury, because, according to their experience, service members and veterans can suffer long-term scars that are not well captured by the current conceptualizations of PTSD or other adjustment difficulties. He further explains that they

are not arguing for a new diagnostic category, per se, nor do they want to medicalize or pathologize the moral and ethical distress that service members and veterans may experience. Nevertheless, Litz et al. (2009) believe that the clinical and research dialogue is very limited at present because questions about moral injury are not being addressed, comprehensively.

In order to describe moral injury further, and to stimulate a dialogue on the subject, Litz et al. (2009) have presented a working conceptual model on moral injury. According to this model, cognitive dissonance occurs after a perceived moral transgression resulting in stable, internal and global attributions of blame, followed by the experience of shame, guilt, or anxiety, causing the individual to withdraw from other people and society. Withdrawal leads to failure of self-forgiveness and self-condemnation. The final result is an increased risk of suicide due to demoralization, self-harming, and self-handicapping behaviours. This model which is described below is a working conceptual model that was presented to stimulate more research in this area. According to Litz et al. (2009) model, cognitive dissonance occurs after a perceived moral transgression resulting in stable internal global attributions of blame, followed by the experience of shame, guilt, or anxiety, causing the individual to withdraw from other people and society. Withdrawal leads to failure of self-forgiveness and self-condemnation. The final result is an increased risk of suicide due to demoralization, self-harming, and self-handicapping behaviours. This model is a working conceptual model that was presented to stimulate more research.

A good understanding of the manifestation of moral injury would be beneficial during the application of clinical care model interventions. Hence, the researcher believes that conducting studies that examines the conceptual framework of Litz et al. (2009) with different populations is important. This would eventually help properly conceptualize the moral injury model and making the development of a psychometric tool to identify psychological, social and behavioural manifestation of moral injury. Further, it is important to understand how clinically relevant the concept of moral injury is and how manifestations and correlations of moral injury culturally differ. Below picture shows the model presented by Litz et al., (2009).

## II. OBJECTIVES OF THE STUDY

- a) To conduct a qualitative study in a prisoners sample to gain a better understanding of the presentation and correlates of moral injury based on the working conceptual model presented by Litz et al. (2009) on moral injury
- b) To study difference in the presentation of moral injury in a prisoners sample than a military sample
- c) To explore culturally different manifestation of moral transgression responses

## III. METHODOLOGY

This study was conducted by interviewing a sample of fifteen (15) Sri Lankan prisoners who have been convicted for homicide (manslaughter and premeditated murders). Qualitative research method was selected due to its ability to provide complex textual descriptions. Sensitive information on personal life of people who committed murders was explored in this research. Hence, the in-depth interview method found to be very suitable for the purpose of the research. The interviews were carried out at the rehabilitation section, Welikada Prison. Thematic analysis method was used to analyse data as it found to be the most common and suitable form of analysis method in qualitative research.

Ethical clearance was taken from ethical clearance board at University of Colombo. Permission to carry out this research at Welikada prison was taken from Commissioner General of prisons, Prison Head Quarters. Only voluntary participants were recruited with a valid informed consent. Following points were included in the informed consent form:

- a) Participation is voluntary
- b) The participants are aware of what their participation involved in
- c) The participants are aware of any potential risks (if there were any)
- d) All questions concerning the study have been satisfactorily answered
- e) The right to withdraw. (A documented consent was signed or initialled if participants wish to maintain anonymity).

## IV. RESULTS AND DISCUSSION

### A. presentation and correlates of moral injury with regard to the Litz et al. (2009) moral injury model

Overall the pattern that is reflected among the participants with regard to the Litz et al. (2009) moral injury model was explored in this research. All participants had experienced moral transgression which is the first step in the Litz et al. (2009) conceptual model. All the participants stated that 'killing' was an act that does not match with their moral codes and sentiments. Statements that reflect the idea of 'cognitive dissonance' appeared as a major theme among fourteen participants out of fifteen. The working causal framework of moral injury by Litz et al. (2009) suggests that cognitive dissonance in post transgression is a key factor of moral injury. Litz et al. (2009) work has further stated that the individual must be (or become) aware of the discrepancy between his or her morals and the experience (i.e., moral violation), that causes dissonance and inner conflict.

"Actually, I am someone who does not like to harm anybody. I have not done harm to anybody previously. What happened is something that does not match my character. Who will be benefited by killing somebody else???...I feel that I am a fair person that had done no harm to any. I have nothing to think, it's difficult to think, I am not sure...I do not know what I did..."

Above extraction from the data shows this discrepancy.

Litz et al. (2009) model on moral injury posits that the type of attributions made about moral violation greatly affects the outcome of moral transgression. Attribution is the process by which individuals explain the causes of behaviour and events. In the current research, attribution types, moral justification and externalization appeared to be major attribution types that do not fall into the three attribution types (global, internal and stable) suggested by Litz et al. (2009). The extractions ascertained from the interviews show how they have externalized reasons for the transgression.

"It happened also due to what influences the world out there. I would not have gone to them if they did not persuade me, and this would not have happened..."

It appears that moral justification and externalization have acted as protective factors that have helped the

participants to reconcile with the cognitive dissonance. The following is an example of how a participant has described his ideas with their own words.

“He does not behave according to his age. He has women everywhere. His wife came for the funeral and asked “son, why did you do this? You should have broken his limbs. The main reason for the death is his vulgarity...”

### **B. Religious explanations as a way of attribution**

Other than moral justification and externalization, religious explanations such as attributing to ‘karmic factors’ also appeared as a type of attribution made by this sample. Seven participants shared such religious and astrological explanation for the perpetration made by them. Attributing to Karmic factors appears to be a practice that has spiritual relevance. Some people have used the word “karma” while others use the word ‘bad time’. ‘Bad time’ can be described as ‘inauspicious time’ in astrology. Faith in the auspicious and inauspicious times is a cultural tenet in Sri Lanka. Both these concepts appear to have a spiritual content even though Buddhism in theory rejects as such could lead one to unwholesome conduct when one is on the path to attain one’s main objective in Buddhist thought. Hence, it’s important to ascertain at this point that attributions could also be due to the fact that ‘moral transgression’ has a close link with religious values. The use of the concepts of ‘karma’ is a Buddhist perspective. Also, concepts of ‘auspicious/inauspicious’ time is a culturally specific belief. Hence, these findings are particular to Sri Lankan context.

### **C. Forgiving as a protective factors**

The moral injury framework posed by Litz et al. (2009) suggested that forgiving is an important part of the process of moral injury. Participants shared their views on self-forgiveness. Thirteen participants out of fifteen forgave themselves for their acts committed.

“I forgive myself. I forgive because, when we forgive, we will not make the same mistake again. We feel happy. Therefore, I would like to forgive. If we do not forgive, we fall back into same trouble again. Then, we are not free. If we forgive ourselves, when we get released from the prison, we can live like a new-born child...”

The above participant has explained that if he forgives himself, it helps to refrain from future wrongdoing.

It appears to be a very good example for a practical experience /reflection of a real life situation from a person with a prison sentence who had been involved in a culpable homicide. Further he described that he could not move forward if he does not forgive himself. Below are some other extractions.

“I forgive myself. I am not angry. I have made up my mind and feeling calm with myself...”

This statement resonates with the definition above by Hall and Fincham (2005). The above person says that he is not angry and he feels calm about himself, which is described in the definition as “...decreasingly motivated to retaliate against the self (e.g., punish the self, engage in self-destructive behaviours, etc.), and increasingly motivated to act benevolently toward oneself.”

“Now I forgive. I accept the mistake because I have gone through prison term I need not worry once I am released by the courts with a punishment, I do not have to worry...”

In this quote, the definition provided by Hall and Fincham (2005) is reflected as well. They have defined self-forgiveness as “...increasingly motivated to act benevolently toward oneself...” The above participant says that “I need not worry once again...I do not have to worry...” (p.622). These thoughts show the motivation to act benevolently toward oneself.

### **D. Shame and guilt**

When proceeding into next levels of the model, it suggests by Litz et al. (2009) that ‘shame’ and ‘guilt’ are major emotions that could lead someone to develop a moral injury. In the current research, ‘shame’ did not appear as a major theme. Yet, ‘Guilt’ was expressed by ten participants. According to motivational traits of ‘shame’ and ‘guilt’, shame leads to desire to hide, escapes or strikes back while ‘guilt’ has motivational desire to confess, apologies or repair (Tangney & Dearing, 2003).

### **E. Social withdrawal**

Litz et al. (2009) model also suggests that ‘shame’ leads to social withdrawal. However, social withdrawal did not appear as a major theme among the participants. Eight participants out of fifteen indicated that they have a positive connection with the larger society. Only two people indicated that they voluntarily withdrew from

social networks and society. They said that they have continued their relationships with their own families as well. The theme 'family relationships' was identified as an important theme that was highlighted by almost all the participants. All participants mentioned that they are looking forward to reintegrate with their families when they get released from the prison. Eleven participants in this sample said that they have a good and healthy connection with family via telephone and home visits. The statements they made during the interview revealed that they were satisfied with the relationship with family. Only four of them said that they have less connection with the family.

"Elder son does everything including the courts related issues. Also his younger brother's needs, he did everything for twenty months. Now, we have fewer burdens. My hope is to be released and live with my wife and children..."

According to the above quote, it appears that this person is less distressed due to having fewer burdens currently. He described that his elder son has taken up more responsibilities. So, he has a hope to live with his family once he is released which is good evidence for the future with strong family relationships which is a positive step for a psychologically disturbed person. Below is another example of satisfaction with family support.

"My parents did not ask about the incident. But they looked after me, cared me. Always my father is behind me. My brother looks after any issue that I face. I received a big relief from my parents. They always tried to rescue me. Even now, if I call and inform, they would do anything. The relative also come to see me..."

"I have taught my children what I have learned. I deeply trust my wife and the children..."

The above statements made by three participants show their satisfaction and joy with family relationships, less distressed about the status of family members. Only two people said that they withdrew from social networks. Five people said they were ostracized from social relations in the community. Considering the overall social connections, it does not appear that social withdrawal as a major theme among the participants.

## F. PTSD symptoms

According to the Litz's model some of the PTSD symptoms manifest as a moral injury. Only two participants revealed 'avoidance behaviours'. Other thirteen participants said that they do not avoid talking about the incident. Participants who consented only were interviewed in this research. Only One participant out of fifteen revealed that he had suicidal thoughts. Other self-harming behaviours were absent in fourteen participants out of fifteen. Self-condemnation was present in the same participant who indicated suicidal thoughts. Hence, it gives the impression that those fourteen participants out of fifteen have not gone through the latter steps of the Litz et al. (2009) working conceptual model though they had experienced cognitive dissonance and guilt.

## G. Post moral transgression growth

Hence, findings of this research give an impression for the possible conditions that could prevent someone who had transgressed their own moral values, from developing negative mental health issues or functional impairments associated with moral transgression. Religious activities appeared to be having primarily helped them to understand the importance of 'forgiving' and value of 'corrective' approach. Two people revealed that they learnt more advanced lessons of Buddhism by reading Buddhist scriptures and achieve 'post moral transgression growth'. The religious books have helped them to find meaning in life, future, and concepts such as 'attachment'. Same two people revealed that their understanding of life changed positively after coming to the prison that could be similar as 'post crisis growth'. The concept of 'post crisis growth' is widely discussed in the literature on post trauma. Below are few extractions of their change in the prison.

"I met a brother who is knowledgeable on Buddhism and meditation. He advised me well. I did not know even five precepts properly. Now I am reading the 'Abhidharma' (Buddhist metaphysics) It's little difficult to understand. But, I am trying. It helps me to cope with the situation. The Buddhist path helped me..."

"Initially, I had distressing thoughts. I learnt Buddhism and meditation. I am going to the Hindu Kovila as well. I go to the temple to chant and for meditation...I do not feel sad. I learnt a lot at the prison. I learnt not to even harm an animal. I learnt in the prison, may be more than from a university..."

“When the thoughts of the incident come to my mind, I do not ruminate with the thought. I just tell that thought- ‘Please; go away....I have something else to do’. I observe the thought in my mind. If the thought stays in the mind, I let it be. Then I think about virtues of the Buddha. Then that thought goes away. I attended three days meditation programmes. I attain sil (chanting in solitude and meditation) on every full moon poya days (a day of Buddhist religious observance). I know ‘Yoga’ meditation to some extent...”

“When I get distressing thoughts, I play .....and play carom. I do something else. I try to shift my thoughts...”

The above participant revealed that sport activities helped him to reduce distressing thoughts.

Extractions above show the participants ‘own reflections on their ‘post moral transgression growth’ in life. Religious activities and understanding appear to have a strong connection with ‘post moral transgression growth’ that reflect in the statements shared by above participants.

#### H. Protective factors

According to the information received from participants mainly, sport activities, religious activities, singing, dancing, yoga, writing poetry, and participating at other working parties at prison; carpentry, press and bakery are said to have helped with coping distress caused by the moral transgression and current difficulties. Here, they were guided to look at their cognitive dissonance with regard to moral transgression and they were asked what has helped them to cope up with distress. What they gained through above activities was also explored. Those who engaged in dancing and singing and then performed at events revealed that they could understand their skills and it helped them to develop self-esteem. The person who writes poetry said that he tries to give moral lessons to other people in the society by his poetry. Others who did sports activities such as daily exercise and games such as cricket, volleyball, and carom think that those activities have helped them to spend their time effectively and give them a relief when they felt distressful.

## V.CONCLUSION

The current study explored presentation and correlates of moral injury based on the Litz et al’s model in a prisoners’ sample. However, according to this model, final result of the process of moral injury is ‘self-harm’, ‘self-handicapping’, ‘demoralization’ and ‘PTSD symptoms’. Only one participant out of fifteen showed self harming thoughts in the current research sample. Hence, findings of this research give an impression for the possible conditions that could prevent someone who had transgressed their own moral values, from developing negative mental health issues. Culturally specific attribution was identified during the interviews relating to certain incidents in life as a result of Karmic effect. Seven participants shared such religious and astrological explanation for the wrong doing. Attributing to Karmic factors appears to be a practice that has spiritual relevance.

The current research findings of post moral transgression positive change reflect the idea of ‘post moral transgression growth’. Yet, more empirical research on ‘post moral transgression growth’ is needed to explore this concept. It is my view that the policy makers even at the political and administrative levels and in the fields of rehabilitation and prison reforms would benefit if such attempts are encouraged in research.

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# THE USE OF FIRST LANGUAGE IN TEACHING SECOND LANGUAGE VOCABULARY TO SRI LANKAN UNDERGRADUATES

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Tangney, J. P., & Dearing, R. L. (2003). Shame and guilt. Guilford Press. Retrieved from <https://books.google.lk/>  
**Abstract** - English has become the “Global language” (Crystal, 2003) and is taught as the second language in most of the countries around the world. In Sri Lanka too, there is a considerable demand for English Language Teaching (ELT). The research is based on teaching English vocabulary to undergraduates who are non-native speakers of English.

Since majority of the degree programmes are conducted in the medium of English in Sri Lanka, universities take measures to provide language support by conducting English language classes. In the process of teaching English to students of various language capacities, the interference of first language (L1) in teaching second language (L2) could occur in many ways and in many areas. Thus the aim of the research was to find whether the use of L1 in teaching L2 vocabulary hinders the students’ ability in improving their L2 vocabulary.

Fifty first year students and five lecturers of a leading Sri Lankan university were taken as the sample group and the students were put into two groups where one was exposed to L1 in teaching L2 vocabulary. The students were given a pre-test and a post-test where the marks obtained were compared. They were also administered a questionnaire to collect background information. The lecturers were interviewed and their experiences and ideas regarding teaching university students were gathered.

It was found that the students who were exposed to L1 did not show considerable difference in scores including some showing a little decrease in marks whereas the students who were not exposed to L1 showed a remarkable increase in obtaining marks. So it was noted that the use of L1 in teaching L2 vocabulary to university students hinders their ability in improving L2 vocabulary. It was also found that the lecturers use L1 at times in explaining the most difficult vocabulary related to the field of study of the students.

**Keywords** - ELT, hinders L1, L2, non-native speaker

## I. INTRODUCTION

English occupies a pivotal role in today's world. It has been referred to as the world language or 'lingua franca' as it is widely spoken. It has been globally dispersed and has become the prominent medium of international discourse in many regions. It is widely learned as a second language and used as an official language of the European Union and many Commonwealth countries. It is the third most spoken language in the world, after Mandarin Chinese and Spanish (Crystal, 1998).

English is used and taught as a foreign language in many countries. Linguists believe that it is no longer the exclusive cultural property of the Native English Speakers. It is a well known fact that it is a language that is absorbing aspects of culture worldwide as it continues to grow. The increasing use of the English language globally has had a large impact on many other languages, leading to language shift and even death. For this reason, the English language is considered to be forever evolving.

The interference of the mother tongue in teaching English as a second language could happen at any level of English Language Teaching (ELT). The aim of the research was to find out whether the use of first language (L1) in teaching second language (L2) vocabulary to undergraduates of Management hinders their ability to improve L2 vocabulary. The target group was taught Business Communication; English related to management, business and commerce. Another objective was to find out whether L1 is often used in teaching L2 vocabulary. If so, Direct L1 word, L1 definition and L1 explanation were assumed to be involved when using L1 in teaching L2 vocabulary. Thus the research focused on "when teaching L2, in what areas is L1 used?" and the hypothesis was the "Use of L1 in teaching L2 vocabulary to Sri Lankan undergraduates hinders their ability to improve L2 vocabulary".

## II. LITERATURE REVIEW

With the influence of behaviouristic psychology, language learning was seen as a setting up of the habitual behaviour specific to it. According to Koekkoek (1970), "the habits already established for the first language were seen as a source of interference". Together with the second language acquisition which could happen anywhere in the society, the habits of the first language transfers to people. Ray Graham (1984) explains how children acquire the language outside the school without any guidance by any teacher but find difficulties when it comes to teaching it inside a classroom. The reason he presents is the fact that

language teaching is highlighted as a subject in schools. "Problem with language teaching in the public schools is that language is seen first and foremost as a subject to be taught rather than as a medium through which to communicate" (Graham, 1984). The belief that babies and children pick up the mother tongue with great ease than "adults struggle ineffectively with a new language to impose on it the phonology and syntax of their mother tongue" (Macnamara, 1976) becomes significant in this aspect.

Watch arapunyawong & Usaha (2013) states that "L1 interference occurs when L2 learners transfer their own systematic knowledge into the use of the target language". Language interference is also defined as a "cross-linguistic and language transfer which happens in the productive skills like speaking and writing" (Hashim, 1999).

Many researches have been done on L1 interference in L2 learning. Chan (2004) investigated the evidence of syntactic transfer from Chinese to English. 710 Chinese students were given 2 tasks; to translate English sentences and to correct 20 ungrammatically written English sentences into L1. The first language interference was focused on 5 Categories namely copula control, adverb placement, inability to use 'there is', failure to use relative clauses and the confusion in verb transitivity.

Two outstanding researches are being done to observe L1 interference in L2 writing of the Thai students. Bennui (2008) in his study of L1 interference in the writing of Thai EFL students, reveals 3 main categories of first language interference.

1. L1 Lexical Interference: happens due to lack of lexical competence. Since the vocabulary levels of two languages are different, when writing or speaking L2, direct translation of L1 comes leading to make errors in word choice.
2. L1 syntactic interference: related to grammar errors. This type of interference is seen in 7 categories.
  - i. Word order
  - ii. Subject-verb
  - iii. Tense agreement
  - iv. The infinitive
  - v. Verb "have"
  - vi. Prepositions
  - vii. Noun determiners
3. L1 discourse interference: happens due to difference between styles of L1 and L2 text formats including text formats, essay patterns, organization and concepts.

Watcharapunyawong & Usaha (2013) have done a research with 40 second year EFL undergraduates at the Faculty of Humanities and Social Sciences of Thepsatri Rajabhat University, Thailand, with the purpose of investigating Thai EFL students' writing errors in different text types. The students were asked to write 3 paragraphs of 150 words each in 3 genres; narration, description and comparison/contrast. After analysing the writing errors with the supervision of 3 language experts, sixteen L1 interference categories were found. Out of the sixteen, verb-tense is the most frequent error found in narrative writing whereas article error was the most found error in descriptive writing. It is stated that singular/plural form errors are the most frequent in comparison/contrast writing.

#### IV. METHODOLOGY

The research took an experimental research design. Random sampling method was used to select fifty first year undergraduates and five English language lecturers. The undergraduates belonged to two English Groups; each containing 25. The five lecturers were randomly selected among those who taught the same English programme and their university teaching experience varied from 2-10 years.

The survey types were questionnaires, pre and post tests and interviews. The students were given a pre and a post evaluation on vocabulary related to business communication. Students of one class (experimental group) were exposed to first language in teaching second language vocabulary whereas the other group (control group) wasn't exposed to first language in teaching second language vocabulary. After a semester of teaching, their vocabulary performance was analyzed. They were also administered to a questionnaire to collect their views and ideas on second language learning at tertiary level. And also the socio-demographic details such as family background, schools attended for primary and secondary education and the professional qualifications obtained with regard to the target language were taken note of. Five lecturers who conducted the same English programme were interviewed in order to gather their experience and ideas of using first language in teaching second language vocabulary for undergraduates. As ethical consideration, the research did not have any impact on the examination results of the common degree programme of the target group as the pre tests and post tests were conducted apart from the end semester examinations and assessments of the degree programme.

#### V. BACKGROUND OF THE TARGET GROUP

The target group consisted of 50 first year management students who were non native speakers of English. It included 43 native speakers of Sinhala and 7 native speakers of Tamil. Everybody in the target group had done their secondary education in Sinhala Medium and had attended state schools including, National, Central and Popular schools. All of them were reading for the same degree at the University. They belonged to various provinces of Sri Lanka but the majority of the target group was from the western province.

General Certificate of Education (GCE) advanced level (A/L) is the highest and final level of qualification a student could obtain at the secondary level education in Sri Lanka. Since education is free in the country, GCE (A/L) is highly competitive as it ranks the students for free university education at tertiary level. The grading system grades the students as follows.

- A 75 - 100
- B 65 - 74
- C 55 - 64
- S 35 - 54
- W 0 - 34

Thus with regard to the English performance of the target group at GCE (A/L), 8 have got credit (C) passes 22 have got simple (S) passes whereas 20 have failed with (W) passes. None of them have obtained either A or a B pass.

#### A/L English Results

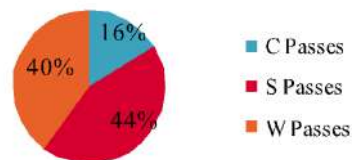


Figure 1: Advanced Level English Results

As for the highest qualification of English of the target group, 18 students said that it was General Certificate of Education- Ordinary Level (GCE- O/L) English whereas 24 students stated that it was A/L General English and 8 students said its neither O/L or A/L but its other courses they have successfully completed after O/L or A/L.

### English Qualification

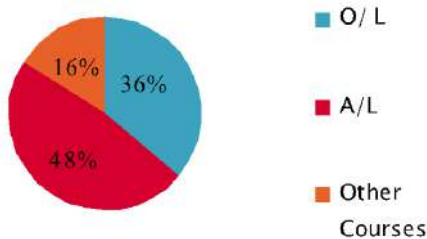


Figure 2: Qualifications in English

Regarding the view point of the Medium of Degree Programmes at University level, 18 students said that it should be English, 26 students said it has to be English even though it is hard for them to follow, 4 students said it should be Sinhala for the students with language difficulties and 2 students were of no idea.

### VI. EVALUATION OF THE PRE-TEST AND THE POST-TEST (EXPERIMENTAL GROUP)

#### Pre Test

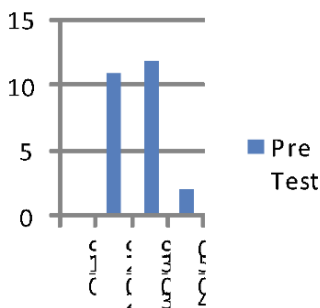


Figure 3: Evaluation of pre-test of Experimental Group

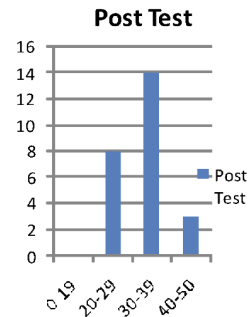


Figure 4: Evaluation of the post-test of Experimental Group

### VII. EVALUATION OF THE PRE-TEST AND THE POST-TEST (CONTROL GROUP)

#### Pre Test

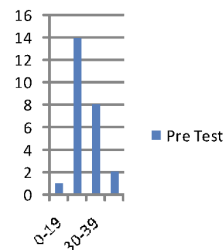


Figure 5: Evaluation of pre-test of Control Group

In the pre-test 1 student has scored between 0-19 and 14 students which marked the majority has scored 20-29, 8 students have scored 30-39 and 2 students have scored 40-50. In the post-test, nobody scored between 0-19, 5 students scored between 20-29, 15 students scored between 30-39 and 5 students scored 40-50.

#### Post Test

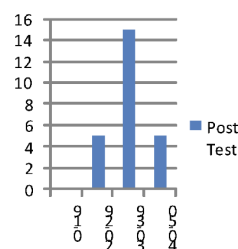
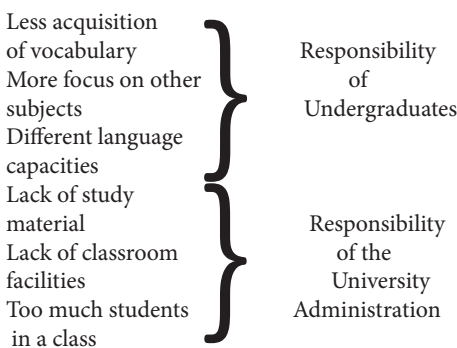


Figure 6: Evaluation of post-test of Control Group

## VIII. FACILITATOR PERSPECTIVE OF THE ISSUE

The interviews held with the 5 English language lecturers revealed that the lecturers face difficulties in teaching not only the second language vocabulary but also the other aspects of English to undergraduates. Their categorization of the reasons and causes of the teaching difficulties are as follows.



The most interesting features in teaching English to undergraduates according to the lecturers are mentioned below.

- Students’ interest in group activities
- Student motivation and curiosity about the language
- Learner friendly classrooms with language teaching facilities
- Student centered and activity based curriculum

## IX. DISCUSSION

It was found that the language lecturers use first language (L1) in teaching second language (L2) vocabulary in the form of L1 explanations and direct L1 words. They find it ‘practical’ to use L1 explanation rather than using L2 definition or L2 explanations.

It was also found that the undergraduates at the Faculty of Management Studies and Commerce are taught Business Communication; English related to business, finance, modern technology and commerce. The course is compulsory for the first year management students to get exposed to a vast area of English vocabulary related to their stream of study.

Even though the medium of the degree programmes at the FMSC is English, the target group finds difficulties to follow their studies in English. The reason for this is that they have done their primary and secondary education in the Sinhala medium and they find it hard to follow higher and advanced studies in English because their exposure to English language is low.

75% of the target group has failed G.C.E (A/L) General English and it was revealed that English language has been neglected and ignored throughout their education process. The aim of the target group had been to obtain 3 A passes for their main subjects, which were the subjects related to commerce stream, at the GCE (A/L). The target group has been successful in the task as they have passed A/Ls with high ranking scores so that they could enter university. But 40% of the target group has failed A/L General English due to the ignorance of the subject and less focus paid to the subject.

Yet 90% of the target group is of the opinion that the medium of their degree programme should be English and they are in need of the language ability and fluency and wish to improve English through the English programme of the university. 80% of the target group is of the viewpoint that the English programme conducted by the university is useful in improving the skills related to English and it suits the academic environment as beginners. 20% state that the skills related to listening should also be given a similar attention in syllabus development.

75% of the target group was familiar with the vocabulary related to commerce and finance. ¾ of the target group has obtained full marks for the vocabulary exercises related to commerce at the pre and post evaluations. Their comprehension related to modern technology and new business trends were comparatively low and it was only 50% of the target group which showed a considerable comprehension in exercises related to the above areas. Thus the target group marked a lack of exposure and a low proficiency level in vocabulary related to novelties in technology and business. It also marked their failure in updating knowledge on novelties of technology and business.

Regarding the comparison of the two groups, the experimental group which was exposed to L1 in teaching L2 vocabulary, did not show a considerable improvement in obtaining marks for the post evaluation paper whereas the control group, which wasn’t exposed to L1 in teaching L2 vocabulary showed an improvement in post evaluation scores.

Thus the progress of the target group which wasn't exposed to L1 was notable. Both charts show a good distribution indicating required standard of undergraduate test papers.

## X. CONCLUSION

Thus the hypothesis; "Use of L1 in teaching L2 vocabulary to undergraduates hinders their ability to improve L2 vocabulary" was proven through the findings. The English Lecturers who teach the management students use L1 in teaching L2 vocabulary as it is required by the students because the students are not of good competency levels and they need the L1 support in acquiring L2 vocabulary.

Implementation of some suggestions could minimize the hindrance of the students' ability in improving L2 vocabulary. The lecturers could use the L2 explanations than giving direct L1 word and L1 explanations. They could use strategies in explaining like giving L2 synonyms and dictionary meaning.

It could be concluded with the note that the undergraduates have realized the value and importance of English in their academic and future endeavours and are keen to improve the skills related to English language. And also the English language proficiency and related skills could be stimulated, inculcated and enhanced through effective teaching methodology and the L2 vocabulary enhancement could be done vastly through the exposure to the L2 vocabulary itself.

## XI. RECOMMENDATIONS

It is important that the students learn dictionary skills. Therefore language lecturers could introduce a lesson on 'dictionary skills' and could introduce a 'thesaurus' so that the undergraduates will not totally depend on the lecturer in finding difficult vocabulary.

The undergraduates should be encouraged to read English newspapers. Newspaper reading sessions and activities related to newspaper reading could be organized in English lectures. This would enhance their vocabulary related to modern technology, new business trends and current issues.

Lecturers should encourage the students to talk in English. This could be implemented by persuading them to ask questions from the lecturer in English where phrases of appreciation could be used as encouragement.

Since the syllabus lacks listening activities, the English language syllabus could be introduced with subject related listening activities. Undergraduates would also get an exposure to good pronunciation and they could concentrate on their pronunciation as well.

Short entertainment sessions should also be introduced to English lectures. This could be done as ice breakers or short lessons on English songs where students could engage in various learning activities while listening. It will keep undergraduates apace with vocabulary on current trends in entertainment and will also broaden their understanding. These measures will not only help the undergraduates improve L2 vocabulary, but also they will become 'added values' to their lives as well.

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# A REVIEW OF LITERATURE ON THE COMMUNITY OF INQUIRY FRAMEWORK

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**Abstract** - The purpose of the current study was to critically analyze the learning in community of inquiry (CoI) framework. In the year 2000 Garrison, Anderson and Archer introduced CoI framework in order to find solutions to reduce the gaps in online learning and the framework that they have introduced has become the most referenced framework of study in online education so far. According to them, a very satisfactory education takes place within a community of inquiry which consists of teachers and students. Further they assume the learning takes place as a result of interaction among social, cognitive and teaching presence (Garrison, Anderson and Archer, 2000). Though the CoI framework has shaped many studies of e-learning in higher education, it is highly recommended that much more research work should be done on this framework to clarify the mounting body of disconfirming evidence.

**Keywords** - Online learning, CoI, Teaching presence, Cognitive presence, Social presence

## I. INTRODUCTION

CoI model presents for online educators a framework which can be used to organize and teach successfully both in online and blended learning environments. The community which is highlighted in CoI model explains that when learners get a secure and encouraging environment to learn without any fear for discouragement and unwanted judgments, they learn with interest which leads for success (Shea, Li and Pickett, 2006). According to many research findings it has already been proven the effectiveness of CoI both in asynchronous

and synchronous learning environments (Garrison & Arbaugh, 2007; Tekiner Tolu, 2010,2013).

According to Garrison et al (2000) the most significant element in this framework is cognitive presence. That is the major element for critical thinking which is used immensely in higher education. Further they hypothesize social presence along with commitment and participation is also needed for higher-order thinking skills and successful collaborative efforts. Social presence stands as a supporter for cognitive presence, indirectly supporting for critical thinking. Further they state if the use of computers in education can support for

establishing social presence, then it can be considered as an effective method in higher education despite its restrictions for written language.

Online courses need more planning and preparation than face-to-face teaching. Teachers should initially have a face-to-face meeting with the students and make a briefing about the course and should create a stress free learning environment for the learners. In the beginning of the course, teachers can offer an opportunity for learners to get to know each other allowing them to have a live session which can support to create better social presence. Social presence can be further enhanced through collaborative activities, teacher availability, prompt feedback and constant encouragement both in synchronous and asynchronous learning environments. Online collaboration is not an easy task as in face-to-face classrooms (Tekiner Tolu, 2010, 2013). In addition Garrison et al (2000) assume when the social presence is

combined with the teaching presence in an appropriate manner it will lead to have a strong cognitive presence which will lead to gain successful intended learning outcomes.

## II. LITERATURE REVIEW

With the rapid growth of online education worldwide, researchers are very interested in finding out its impact on learners both academically and socially (Shea et al , 2006). In these efforts CoI model has gained a significant attention of those researchers when studying about online learning and the practice of it. On the contrary, Swan, Richardson, Ice, Garrison, Cleveland-Innes and Arbaugh (2008) criticize this model with two challenging issues; the first is the lack of common measures in studying the individual presence which makes it difficult for generalizations and the second is only a few studies have researched on all the three presences and the interaction among them. In their conclusion they suggest that some more research should be done to find out whether social presence is needed before establishing cognitive presence. In addition they suggest expansion and application issues related to this model must also be examined.

Rourke and Kanuka (2009) reviewed 252 reports from 2000-2008 which had used CoI framework for their research. Among them 48 reports were used one or more aspects of this framework and only five research had considered to measure the student learning. According to their review deep and meaningful learning do not occur when researchers use CoI framework in their studies just as it is mentioned in the framework. Instead learners are engaged with surface learning not with uninterrupted communication as it is mentioned in CoI. Further they suggest more research should be done to find out the effectiveness of this model on e-learning and how “theorists to respond to the mounting body of disconfirming evidence” (p.19). A conceptual framework of social, teaching and cognitive presence without proper empirical evidence on deep and meaningful learning is not considered as a strong framework to support one’s own research. This suggests learners who are engaged and not engaged in deep and meaningful learning on making evidence-based suggestions on types and quantities of teaching, social and cognitive presence which is related to learning also needed to be investigated.

Annand (2011) also mentions CoI framework does not strongly support for online learning though the influence of social presence for learning experience has been stated too strongly, it does not do so in reality. Not only that the collaboration in social presence has also been overstated. Further he states that though the CoI framework has influenced immensely for online education and makes evident the impact of teacher and learner attribute on cognitive presence, the due acknowledgement has not been given for that. Thus the impact of group efforts on collaborative efforts in the learning processes should be re-evaluated. Sub categories in both teaching and social presence should also be re-evaluated and re-analyzed to find out how they separately support for group vs individual based activities.

Garrison and Arbaugh (2007) discuss about the practical issues in the use of CoI framework in research studies. How best to facilitate social presence in online learning environment would be an essential area when analyzing this framework from practical pedagogical perspective. Creating an environment for open communication and collaboration is also very significant for building a productive and better community of inquiry. Therefore exploring the dynamics of online learning, online collaborative learning and how to create productive online groups are essential areas which also need to be addressed. Audio, video and different other new technologies should be introduced into online learning and its effectiveness and the impact of them on community of inquiry learning outcomes should also be measured. Further they recommend more quantitative and cross disciplinary studies should be conducted by using this framework. More research factors should be identified that moderate or extend the relationship between the elements in CoI framework and online learning outcomes.

According to Dewey (1959) the use and the effectiveness of collaborative constructivist approach in online learning environments should be further explored. Earlier the effective establishment of social presence in online learning environments was considered very significant but after it has been proven that it is possible to develop social presence and online learning communities, now the focus has been given for researching on the effectiveness of collaborative efforts in developing online learning communities of inquiry. To this they have added it is definitely a challenge to construct knowledge collaboratively but more than that, it is challenging to manage the responsibilities of a teacher in such an environment. In designing, facilitating and giving instructions, it is very important to build a

community of inquiry. In conclusion according to Dewey's collaborative constructivism and practical inquiry, CoI is a promising model for online learning both theoretically and practicality. Therefore it is important to study more on the components of the CoI framework and how this framework can be used for developing online courses (Swan, Garrison and Richardson, 2009).

According to the research work of Lambert and Fisher (2013), they provide some further support in designing online courses by using the three elements in this framework. Some sub categories in this framework offer a new insight into how to design the online courses more effectively. At the same time the individual items of each sub category offer weaknesses and strengths which should be addressed to offer more supportive online learning environments for education.

Collaboration and communication skills are very essential for the 21st century and these skills can be best achieved through online environments. By using this framework Lambert and Fisher have designed and organized a course and used proper strategies while creating collaboration among class mates that helped them to motivate and make the learners engage into their activities enthusiastically. In their conclusion they propose to investigate the perception of the students towards the presence of a teacher depending on the existence of cognitive and social presence. The ability or the skills of the learners to use the tools in the newer technology should also be an area to conduct more research, mainly because this directly influences for learning the course content, collaboration and to have communication and to develop a sense of community in online learning environments. Apart from discussion forums, some other newer tools which can be used to create better communities of inquiry in online learning environments should also be found through more research work (Lambert and Fisher, 2013).

### III. DISCUSSION & CONCLUSION

CoI framework has been supporting a considerable number of studies in online learning. Research findings on learners who are engaged and not engaged in deep and meaningful learning support on making evidence-based suggestions on types and quantities of teaching, social and cognitive presence which are related to learning are some required areas for more research.

How best to facilitate social presence in online learning environments would be an essential area that more research should be done, when analyzing this framework from practical pedagogical perspective. As Swan, et al. (2008) mention, it is also needed to find out whether social presence is needed before establishing cognitive presence. Since only a few studies have researched on the CoI framework, it is essential to research more on all the three presences and interaction among them in online learning. As Swan, et al (2008) recommend expansion and application issues related to this model must also be examined.

Exploring the dynamics of online collaborative learning and how to create productive online groups are essential areas which also need to be addressed through more research work. Audio, video and different other new technologies should also be introduced into online learning and its effectiveness and the impact of them on community of inquiry learning outcomes should also be measured by conducting more research work. More quantitative and cross disciplinary studies should also be conducted by using this framework. More research factors should be identified that moderate or extend the relationship between the elements in CoI framework and online learning outcomes.

It is also needed to investigate the perception of the students towards the presence of a teacher depending on the existence of cognitive and social presence. As Tekiner Tolu (2010, 2013) mention when teachers use CoI model for their online teaching, it is in the hands of the teacher to construct and design a proper syllabus to achieve course objectives and learner satisfaction. They should design the study content in a well-structured and organized manner to promote critical and reflective thinking.

The ability or the skills of the learners to use the tools in the newer technology should also be an area to conduct more research, mainly because this directly influences for learning the course content, collaboration and to have communication and to develop a sense of community in online learning environments. In conclusion, though the CoI framework has shaped many studies of e-learning in higher education, it is highly recommended to conduct more substantial studies on learning in CoI.

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# THE IMPACT OF ACADEMIC EMOTIONS ON LANGUAGE LEARNING IN THE UNIVERSITY CONTEXT: A NARRATIVE REVIEW

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**Abstract** - Emotions affect learning in general and language learning (LL) in particular since they contain useful information that guides human cognition, behaviour and motivation. As such, emotions experienced in an academic setting affect the learner in a variety of ways. University students are frequently affected by emotions as a result of the difficulty in adjusting. This condition is observed as having impacted on LL, particularly on English, which has now become a very decisive factor in academic learning and achievement in Sri Lanka. The study aimed at identifying the wide array of emotions that are experienced in academic settings, their properties, the theoretical underpinnings, sources, functions and the impact of positive academic emotions (PAE) and negative academic emotions (NAE) on LL. It was also expected to identify the research trends in emotions and LL over the decades. This article is composed in the form a narrative review for which 30 studies on emotions and learning during the past 16 years were explored. A narrative inductive method was utilized to identify patterns across gathered data and to condense varied secondary data gathered from extensive reading into a summary format. The information found were analysed thematically in relation to the research questions. The findings suggest that, it is very difficult to set clear cut rules to prove positive emotions (PE) foster and negative emotions (NE) hinder LL for they serve different useful purposes. The impact of emotions on LL should therefore be further analyzed theoretically and investigated empirically pertaining to

different contexts. There also exists a need to empirically test the existing limited theories on emotion to figure out the range of their validity within diverse contexts. The major implication derived from the study is that, language teaching in Sri Lankan universities, where English is taught as a second language (L2), is quite a mindful undertaking which should be planned and carried out with great care bearing in mind the strong relationship between emotions and learning.

**Keywords** - Emotions, Academic Emotions, Learning, Foreign & Second Language Learning

## I. INTRODUCTION

Individual variables have widely been known and proven to have a major impact on human beings. Among them, affective variables impinge strongly on everything people do and particularly on learning. This study revolves on the idea that, “emotions are fundamental to learning” (Hinton, Miyamoto, & Della-Chiesa, 2008 as cited in Ismail, 2015, p: 30) and contain useful information that can regulate cognition and behaviour (Bless & Fiedler, 2006; Izard, 2002 as cited in Valiente, Swanson & Eisenberg, 2012). Research has demonstrated that emotions play a significant role in the process of learning and academic achievement (Randler, Glaser-Zikuda, Vollmer & Mayring, 2011 as cited in Ismail, 2015). However, research on emotions in learning is still scarce (Imai, 2010; Méndez López, 2011;

Pekrun et al., 2002; Stuchlíková et al., 2013). Moreover, the different approaches and empirical studies on the interplay of learning and emotions apparently correspond to each other only to a low extent (Hascher, 2010). Pertaining to LL, the research base on the impact on emotions is even lesser. Scovel (2000) (as cited in Arnold, 2009) notes that emotions might well be the factor that most influences LL, but, are the least understood by researchers in Second Language Acquisition (SLA). This might be due to the fact that affective variables are difficult to measure. Damasio (1999) wrote (as cited in Garrett & Young, 2009) emotion was too subjective, elusive, vague and not trusted in the laboratory. Nonetheless, many scholars including Arnold (2009); Dulay, Burt & Krashen, 1982 as cited in Krashen(1992); Gardner (2010); Gardner & MacIntyre (1993); Goetz & Hall (2013); Henter (2014); Ismail (2015); Méndez López (2011); Méndez López & Aguilar (2013); Pishghadam, Zabetipour, & Aminzade (2016); Siročić (2014); Stuchlíková et al. (2013) have investigated that affect plays a significant role in LL.

The present study was conducted to investigate the impact of academic emotions on LL. Emotions experienced in an academic environment, for instance, enjoyment of learning, pride of success or test-related anxiety, to name a few, can be termed as 'academic emotions' (AE) (Pekrun et al., 2002). The term can precisely be defined as "the emotions that are directly linked to academic learning, classroom instruction, and achievement" (Pekrun et al., 2002, p: 92). As Pekrun et al. (2002) suggested, the sphere of academic emotions may include students' achievement emotions experienced in academic settings, but goes beyond emotions relating to success and failure by also covering other emotions relating to instruction or to the process of studying (see Table 1).

Within the university context, knowing how to regulate emotions properly helps the process of learning in general and Second Language (L2) and Foreign Language (FL) learning in particular. Learning English as a L2 or a FL has presently become a compulsory study area in the universities and knowing how to communicate appropriately in English has become a very decisive factor in academic achievements. Besides, it is commonly observed that the university students encounter a lot of difficulties when expressing themselves in English during lectures, presentations, viva voce and in written assignments and examinations as well. This is an effort to identify how these problems are affected by the range of emotions experienced by students.

Méndez López (2011) has claimed FL learners are prone to experience a range of emotions and feelings due to internal and external factors. A major problem encountered by university students is that they are frequently subjected to emotional upheaval due to the difficulty in adjusting (Pancer et al., 2000). This difficulty is caused by various reasons. Significant numbers of first-year students report moderate to high levels of loneliness (Cutrona, 1982 as cited in Pancer et al., 2000) and homesickness (Fisher & Hood, 1988 as cited in Pancer et al., 2000) and many report difficulties keeping up with their academic work (Levitz & Noel, 1989 as cited in Pancer et al., 2000). It can also be observed that students are emotionally affected as a result of personal matters such as; forming new relationships, relationship break-ups, family problems, financial issues and stress.

Hence, the review was composed exploiting the important findings of 30 previous studies on learning and emotion carried out from year 2000 to 2016 in order to explore the impact of AE on LL with a special focus on the university context. To serve this purpose, the study aimed at identifying different emotions and properties of emotions that students experience in academic settings, the theoretical underpinnings, sources, functions and the impact of PAE & NAE on LL. It was also expected to identify the research trends in emotions and LL to present suggestions for future research.

Despite the importance, in Sri Lanka and elsewhere, very limited number of research has been published on the impact of AE on LL. It is believed that this review will be an important effort that would contribute to the existing body of knowledge. It will also provide insights to language teachers in order to better assist the students by understanding and regulating learners' emotions in fostering learner-friendly classrooms to enhance LL.

## II. METHODOLOGY

Emotions in educational settings are said to be context-dependent and subjective responses to a specific situation, object or person (Do & Schallert, 2004; Hascher, 2010). Therefore, it is very unlikely that emotions are easily measurable, the causes of emotions are easily identifiable and the results of a study on emotions are easily generalizable. This nature of emotions made the present study to be based on a qualitative approach which gave new insights into the impact of AE on LL. As Jeon et al. (2010, p:02) defined, qualitative studies are those

aiming to “uncover and understand a phenomenon, a process, or perspectives and worldviews of people, with or without a particular theoretical orientation, using typical qualitative methods for sampling, collecting, analysing, and interpreting data”. Besides, qualitative research is especially important in the behavioural sciences where the aim is to ascertain the underlying motives of human behaviour through which various factors that stimulate people to behave in a particular manner or that make people like or dislike a particular thing can be analysed (Kothari, 2004).

The present study takes the form of a narrative review which is a qualitative analysis of existing research on a selected topic. “Narrative is suggested as a knowledge-generating method and its underlying hermeneutic approach is defended as providing validity and theoretical structure” (Jones, 2004, p:95) and according to Pavlenko & Lantolf (2000) (as cited in Garrett & Young, 2009) in recent years narrative genre per se has gained increasing stature in Psychology, Sociology, Sociolinguistics, and Anthropology as legitimate and rich data sources for a variety of investigations including that of narrative construction of selves and realities.

A narrative inductive method was utilized to review research articles where a rigorous process of systematic reading of research articles and coding of the information gathered was done to identify patterns across gathered data. The information found were analysed thematically in relation to the research questions. Thematic approach has been demonstrated by Braun & Clarke (2006) as a flexible approach that can be used across a range of epistemologies and research questions to analyse qualitative data. The purposes for using an inductive approach were to condense extensive and varied secondary data into a summary format and to establish clear links between the research objectives and the findings derived from the data (Thomas, 2006).

Composing a narrative review on the impact of AE on LL enabled the researcher to comprehend more about the topic and to get a deeper understanding of the range of emotions that are common in academic settings. Additionally, it helped identify the methods that had been utilized by researchers to study the impact of emotions over the past years. In connection with the research questions, the study apparently uncovered the vast array of AE experienced by the university students, the theories of emotion, the sources & functions of AE and the effects of PAE & NAE by adapting the said methodology.

### III. RESULTS, DISCUSSION AND CONCLUSION

Though emotions play a major role in learning, the study revealed that, only after the acceptance of the role of affective factors in SLA, the impact of emotions on LL has been identified as an interesting area for research (Mihaljević Djigunović & Legac, 2008 as cited in Siročić, 2014). However, a majority of the recent studies related to the impact of emotions seemed to be largely found on learning a FL than a L2. For example, out of 15 studies found on affect in FL and L2 learning, 10 studies were found on FL learning, 04 were found on L2 learning and only 01 found on both. Nevertheless, all the studies witnessed that affective variables play a significant role in FL and L2 learning. Hence, it was noted that, whatever the language context it be, the impact of emotions on learning is significant.

This section of the review presents, elaborates and discusses the results of the study based on different themes: properties of emotion, theories of emotion, emotions experienced in academic settings, sources & functions of AE, the impact of PAE & NAE on LL and past research trends. It will also provide concluding remarks and a glimpse of possible areas for future research.

#### A. Properties of Emotion

It was found that, the major problems encountered by the researchers of emotion in learning can be attributed to the theories of emotion and the confusion about the definition of ‘emotion’ (Hascher, 2010) since over 100 different definitions of ‘emotion’ (Kleinginna & Kleinginna, 1981 as cited in Hascher, 2010) and many similar terms that are often used interchangeably like ‘feeling’, ‘mood’, ‘affect’ or ‘affective reaction’ exist (Davidson et al., 2003 as cited in Hascher, 2010). However, it is commonly believed that emotions are intense, short-lived affective states to particular stimuli and usually have a cause and clear cognitive content (Do & Schallert, 2004; Hascher, 2010; Imai, 2010). They are portrayed as ‘ways of being’ and ‘holistic episodes’ (Schutz et al., 2006, p. 345 as cited in Hascher, 2010), observed, felt in the body, and can be expressed, disguised towards others but rarely towards oneself (Hascher, 2010). It was also observed that many identify the affective component as a subjective and individual experience of a person (Do & Schallert, 2004; Fehr & Russel, 1984 as cited in Imai, 2010; Hascher, 2010), conversely, Imai (2010, p.279) argues that “emotions

are not just an individual's private inner workings in response to external stimuli but are socially constructed acts of communication that can mediate one's thinking, behaviour and goals".

It had further been examined that emotions have multiple aspects and contain multiple components. The multiple aspects of emotions: physiological, psychological, behavioural (Schutz et al, 2006 as cited in Hascher, 2010) and social aspects (Imai, 2010) lead emotions to contain multiple components, usually five: the affective, cognitive, motivational and physiological components which are significant in the process of teaching and learning (Scherer, 1987; Izard, 1994 as cited in Hascher, 2010 Stuchlíková et al., 2013). Additionally, there is a strong neurobiological support for the importance of affect for learning (Arnold & Fonseca, 2009). It was found that from the perspective of neuroscience, affect is a part of cognition (Schumann, 1994 as cited in Arnold, 2009) and much of the affect that humans generate is likely to be non-conscious (Davidson, 2003).

**B. Theories of Emotion**

The importance of the close association between learning and emotion is not at all new but was already pointed out by the early Greek philosophers, influential psychologists and by innovative educators in the history (Hascher, 2010). In spite of the obvious relationship between learning and emotion, very little is known about it. For decades, learning was mainly analysed in terms of cognitive or motivational aspects to gain a deeper insight into the complex area of learning, consequently, affective processes were ignored when forming learning theories (Hascher, 2010). However, theories and models introduced from recent research on emotions in learning such as, control-value theory of achievement emotions (Pekrun et al., 2007), socio-cognitive model of the development of academic emotions (Goetz et al., 2006), the socio-educational model (Gardner, 2010), expectancy-value theories of emotions (Turner & Schallert, 2001 as cited in Pekrun et al.,2007) bear witness to the emerging attention towards emotions associated in the process of language teaching and learning.

Nevertheless, emotional diversity implies that theory-driven approaches to students' emotions which restrict the range of emotions considered for theoretical reasons may be in danger of missing important parts of students' affective life (Pekrun et al., 2002). Some of those approaches to emotions like "control-value theory of achievement emotions by Pekrun (2000), models addressing the effects of emotions on learning and performance (Fredrickson, 2001; Pekrun, 1992b; Pekrun et al 2002a; Zeidner, 1998,

2007), transactional theories of stress appraisals and related emotions (Folkman & Lazarus, 1985), attributional theories of achievement emotions (Weiner, 1985) and expectancy-value theories of emotions (Pekrun, 1984, 1988, 1992a; Turner & Schallert, 2001) also suggested that they are limited only to particular emotions" (as cited in Pekrun et al.,2007) as opposite to the wide array of emotions experienced by learners in academic settings.

**C. Emotions Experienced in Academic Settings**

It was found that, theoretically, students experience a rich diversity of 'self-referenced, task-related, and social' emotions in academic settings (Pekrun et al., 2002) although most of other emotions except anxiety have been neglected in research. According to (Pekrun et al., 2002), emotions that are experienced in academic settings can be summarized into the list of emotions depicted in Table 1.

**Table1. The Domain of Academic Emotions: Examples (Adapted from Pekrun et al., 2002)**

Emotions in Academic Settings		
	Positive	Negative
Task (caused by task) & Self-related (caused by self) Emotions		
Process of studying (instruction)	Enjoyment Enthusiasm Excitement	Boredom
Prospective (Outcome expectancy)	Anticipatory Joy Hope	Hopelessness Anxiety
Retrospective (when success or failure occurred)	Joy about success Satisfaction Pride Relief Contentment	Sadness Disappointment Shame and guilt Tense Frustration
Social		
	Gratitude Delight Empathy Admiration Sympathy & love	Anger Disgust Jealousy & envy Contempt Antipathy & hate

Identifying and capturing different types of emotions experienced by students has been a challenging endeavor. Those emotions engendered in educational contexts are said to be a result of the evaluation students make



of particular situations while learning (Pekrun, 2000 as cited in (Méndez López, 2011). “These evaluations are influenced by previous experiences, the social context and their personal goals” (Pekrun et al., 2002; Sansone & Thoman, 2005 as cited in Méndez López & Peña Aguilar, 2013, p: 112). This is of particular relevance to the learning of a FL or L2 since students mostly come with previous positive or negative experiences; in this case, the English language learning experiences in schools or private tuition classes, which are sometimes very different from the new learning environment; pertaining to the present study, the English language learning experience in the university and students. The students in a university may also have a diversity of motives for engaging in FL learning. The interplay of all these variables in one emotional event during classroom instruction may have different meanings for individual students and cause diverse effects on their motivation (Do & Schallert, 2004) and LL.

#### **D. Impact of PAE and NAE on Language Learning**

PE have long been perceived and proved as facilitative while NE have been considered imposing negative impact on learning. For example, as cited in Bryan, Mathur & Sullivan (1996, p: 154), “positive affective states have been found to increase memory on various tasks (Potts, Morse, Felleman, & Masters, 1986); mastery of a discrimination task (Masters, Barden, & Ford, 1979); altruism (Isen & Levine, 1972); and child compliance (Lay, Waters, & Park, 1989)” whereas negative affective states, have been found to produce “low-effort processing of information and the use of less complex semantic processing strategies (Ellis, Thomas, & Rodriguez, 1984) and lower cognitive processing effort” (Leight & Ellis, 1981 as cited in Bryan et al., 1996, p: 154). Moreover, with his metaphor of the affective filter, Krashen (1992) warned about the emotional variables that may interfere with the reception and processing of comprehensible input while learning, thereby, highlighting the importance of finding ways to establish a positive affective climate within class rooms.

Recent research findings also manifest that positive affect can provide invaluable support for learning just as negative affect can close down the mind and prevent learning from occurring altogether (Arnold, 2011). As cited in Simonton (2016), enjoyment and performance has a positive association (Chen et al., 2008; Pekrun et al., 2009) and similarly, it has been found that when students learn content that is perceived as controllable and is valued, it is likely to evoke feelings of enjoyment in the learner (Pekrun, 2006). This implies the importance of using

content-based learning approach as a strategy for getting students interested in the material. As Chomsky (1988) said, about 99% of teaching has to do with getting students interested in the material (Arnold, 2009). These findings provide important implications to material developers in the Sri Lankan university context.

It had further been found that, affectively positive environment puts the brain in the optimal state for learning: minimal stress and maximum engagement with the material to be learned (Arnold, 2009). Fredricks et al., 2004; Fredrickson, 2001(as cited in Simonton, 2016, p: 09) have discovered that “experiences of positive emotions such as enjoyment trigger higher levels of student engagement whereas boredom can facilitate feelings of alienation and disengagement”. However, the findings of a study conducted by Pretz, Totz & Kaufman (2010) did not support the general conviction which was also their hypothesis; implicit learning would be enhanced by positive mood and intuitive cognitive style. Moreover, Méndez López & Peña Aguilar (2013) claim that students embraced NE as learning opportunities because they referred to these negative events in class as a way of understanding what they were doing wrong and how to improve on that particular skill. Therefore, it is very difficult to set clear rules to prove PE foster learning and NE are detrimental (Bless & Fiedler, 1999 as cited in Hascher, 2010).

It is obvious that any classroom situation is influenced by the relationship between learning and affect but with LL this is especially crucial since the learner’s self image is more vulnerable when he or she does not have the mastery of language (Arnold, 2011). Therefore, being fully aware of the emotional state of the learner and strategically steering the classroom environment in order to enhance LL should essentially be facilitated by the language teacher. This is very important in the Sri Lankan university context where English is taught as a L2.

#### **E. Sources and Functions of Emotions**

Personality of the learner, day of the week, time of the day, weather, stress, age, sleep, exercise, social activities and gender can be generally identified as sources of emotions (Hume, 2012). However, three major proximal sources of emotions—genetic dispositions, physiological processes and cognitive appraisals, have been identified pertaining to an individual (Pekrun et al., 2002). Since AE are domain-specific variants of emotions in general, these three main sources should be applicable for this class

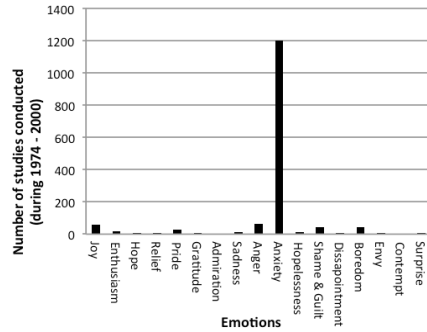
of emotions as well. Although genetic dispositions and physiological processes of students are beyond the control of language teachers, emotionally relevant appraisals of students may be shaped by their instructional and social environments, implying that research on appraisals and their environmental antecedents may help in designing measures of prevention, therapy and optimization (Pekrun et al., 2002). With regards to LL, learning context, situation and materials also carry emotional potential (Hascher, 2010).

Emotions serve many functions in LL. Darwin (1965) argued that emotions developed over time to help humans solve problems and they motivate people to engage in actions important for survival. All emotions, both positive and negative, serve useful purposes (Hume, 2012). PE accelerate assimilation to incorporate new information into existing knowledge whereas NE accelerate accommodation to take in new information with less regard for what is currently known (Bless & Fiedler, 2006). Emotions assist accuracy and efficiency of thinking processes; help learning and recalling memory, facilitate complex cognitive functions that require flexibility, integration, and utilization of cognitive material; form perceptions and influence people to behave in particular ways (Bryan et al., 1996). Schürer-Necker (1984, 1994) (as cited in (Hascher, 2010), investigated that for persisting with a text, emotions like joy, surprise or even disgust were important, thus, content needs to be emotionally touching to be processed and remembered well, which is a major implication for the curriculum developers and material writers.

**F. Research Trends in Affective Factors**

When considering research trends in affective factors, anxiety; particularly test anxiety, is the only emotion that has extensively been researched and continuously attracted the researchers over the years (Hascher, 2010; Goetz & Hall, 2013; Pekrun et al., 2002; Schutz & Pekrun, 2007). It was found that out of 1514 studies conducted on emotions in learning and achievement, during 1974–2000, approximately 80% of studies were related to anxiety (Pekrun et al., 2002) (See Figure1). Apart from test related anxiety, language anxiety has also been researched far more than the other emotions. For example, Pishghadam et al. (2016); Henter, (2014); Siročić, (2014) have investigated on language anxiety which has been found as “negatively affects willingness to communicate and quality of performance” (MacIntyre & Gardner, 1991, 1994;

MacIntyre, Noels & Clément, 1997 as cited in Siročić, 2014, p: 07). Investigations on PE were remarkably less and examining NE has thus been more prevalent among researchers (Pekrun et al., 2002).



**Figure 1. Studies conducted on emotions in learning and achievement during 1974–2000 ( based on Pekrun et al., 2002)**

The findings further revealed that, at present, there is a tendency among researchers to ascribe phenomena such as individual variables, multiple intelligences, emotional intelligence, collaborative learning and student engagement into research related to emotions, which is a positive sign. Additionally, it was uncovered that both quantitative and qualitative methods were used to study emotions in academic settings. The most prevalent quantitative methods found were hypotheses testing (Pekrun, et al., 2002) and co-relational studies. Introducing different emotion scales to measure emotions was also observed as common. On the other hand, case studies were popular in qualitative studies. Personal narratives of L2 learners, either in the form of the diary studies or in the more structured form of learner memoirs, also seemed to have recently received increased attention and a trusted source to gather qualitative data on emotional experience (Block, 2003; Kramsch, 2003; McGroarty, 1998; Pavlenko, 2001; Pavlenko & Lantolf, 2000; Schumann, 1998; Young, 1999) (as cited in Garrett & Young, 2009). Laboratory-based experimental research on mood effects also were used to measure emotions (Pekrun et al., 2002). Grateful to the research findings in the literature, today, interest in affect has taken on even greater importance for language teaching practices. For example, the Common European Framework of Reference for Languages includes ‘Existential Competence’ which is composed of the elements of the affective domain (Arnold, 2009). Moreover, “the current concept of learner-centered teaching also links with a concern for affect in the classroom” (Arnold, 2009, p. 146).

It has been ascertained from the findings that “supporting students’ emotions in language learning classrooms can help students to cope with feelings inherent to language learning experiences and to the development of a positive attitude towards themselves as language learners” (Méndez López, 2011, p:44). Pishghadam et al. (2016) have also emphasized the necessity of helping students manage, regulate, and control their emotions and feelings in language classrooms. As it was observed, “research has neglected when and why emotion is associated with academic success” (Valiente, Swanson & Eisenberg, 2012, p: 07), further research can be carried out to investigate the phenomenon.

In conclusion, it was discovered that emotions are fundamental to learning in general and LL in particular. Findings suggest that studies on emotion and learning were largely found on FL than on L2 and anxiety was the only emotion that was extensively tested while all the other emotions including positive emotions were neglected. Taken all together, there are a handful of limited but interesting theories on emotion which need to be empirically tested to figure out the scope of their validity within different contexts. This implies that it still remains as an open question as to how these theories fit into the realities of the university education. The major implication is that, since university students are frequently subjected to emotional upheaval due to various reasons, language teaching in universities, especially where English is taught as a L2, is a mindful venture which should be planned and executed with great care acknowledging the strong relationship between emotions and learning. It was also found that, it is very difficult to set clear rules to prove PE foster and NE hinder language learning for they serve different useful purposes. Therefore, the impact of emotions on LL should further be theoretically analyzed and empirically investigated pertaining to different academic contexts in Sri Lanka rather than interpreting them in general terms. For future research, an actual study to assess the impact of emotions in the Sri Lankan university context can be done to see whether the existing theories would be qualified. Further, conducting more research on the impact of positive emotions may also reveal certain uncovered aspects.

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- Abstract** - The purpose of this study was to examine factors influencing the adoption of agricultural practices among small holder farmers in Eravur Pattu of the Batticaloa District. Agriculture is the principal source of

# CROP FARM BASELINE SURVEY IN ERAVUR PATTU OF BATTICALOA DISTRICT WITH SPECIAL REFERENCE TO SOCIOECONOMIC FACTORS, CULTIVATION PRACTICES, EXTENSION SERVICES AND CONSTRAINTS

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food and livelihood in Sri Lanka. Demographically it is the broadest economic sector and plays a significant role in the overall socio-economy of developing countries like Sri Lanka. A predesigned questionnaire was used to find out the socioeconomic factors, cultivation practices, extension services and constraints in crop cultivation. Primary and Secondary data were collected from the Agrarian service centres and crop farmers by means of a questionnaire survey among randomly selected 120 farmers during the period of April to June 2016 in 3 AI ranges in Eravur Pattu. The information regarding those factors and issues were analyzed using SPSS (Version 22) and Microsoft Excel package. It showed that 84% of the respondents were male and the majority of respondents (48%) fall between the age range of 30-40years. 48% are at primary education level and the size of the farming of 44% is 5 members. The main occupation of 56% is farming. The study further revealed that 54% of the farmers use Gravity irrigation (tank). When considering the land ownership, all farmers (100%) have their own land in the Maha season. But 58% of farmers have their own land cultivation in the Yala season. 64% of the farmers have leased land for doing

cultivation in Maha season and 56% in Yala season. 82 farmers (68%) cultivate paddy in large scale at both Maha and Yala seasons. At the time of survey, Brinja, Maize and Groundnut are the crops being cultivated widely in large scale as well as in their home garden.

**Keywords** - Crop farm, socioeconomic factors, farming constraints, Eravur Pattu

## I. INTRODUCTION

Agriculture still offers the leading source of livelihood, and contributes a great percentage to national income for most developing countries around the world. The majority of Eravur Pattu farmers are small-scale farmers who depend mainly on agriculture for their livelihoods. Agriculture provides food for their families and cash to meet their daily needs such as housing and school fees. To meet the family food and financial demands, small-scale farmers are obliged to adhere to good agricultural practices which are fundamental for high productivity.

Ensuring food for all, today and in generations to come, is one of the greatest challenges facing the world community. Food security is defined as the ability of people to meet their required level of food consumption at all times; it is considered by many to be a basic human right. (FAO, 1997). Therefore, boosting the rural economy, particularly through increased agricultural production, is one of the chief means of alleviating poverty and increasing food security (Pinstrup-Andersen and Pandya-Lorch, 1998). In explaining productivity growth, economists originally limited themselves to the role of conventional inputs such as land, labour, physical capital, water and chemical inputs. However, the failure to explain productivity growth adequately led them to examine the role of human capital and public goods, such as education, agricultural research and extension and publicly provided infrastructure (Mankiw, Romer and Weil, 1992). Public policies that have a strong link to agricultural productivity such as policy reforms were also examined (Auraju, Chambas and Foirry, 1997). Socio-psychological trait of farmers is important. The age, education attainment, income, family size, tenure status, credit use, value system, and beliefs were positively related to adoption. The conditions of the farm include its location, availability of resources and other facilities such as roads, markets, transportation, pests, rainfall distribution, soil type, water, services, and electricity (Chi and Yamada, 2002). In these circumstances, current study was conducted to find out the socioeconomic factors, cultivation practices, extension services and constraints in crop cultivation in Eravur Pattu.

**II. METHODOLOGY**

A questionnaire survey was conducted in order to have a clear vision on the socioeconomic factors, cultivation practices, extension services and constraints in crop cultivation of the farmers who cultivating the crops in the Eravur Pattu of Batticaloa District. (Figure 1). This research was continued with the primary data were collected from three Agrarian service centres (Table 1) with the help of Agricultural Instructors and secondary data were collected from farmers who cultivating the crops in the Eravur Pattu of Batticaloa District by means of a questionnaire survey among randomly selected 120 farmers during the period of April to June 2016. According to the guidance of Agricultural Instructor, a visit was made to farmer’s cultivated lands of each 3 Agrarian service centres in each AI range in order to collect essential details from farmers.

Therefore interview was made among randomly selected farmers at their doorstep and their field. Finally, the raw data was gathered and spreaded in a Microsoft Excel spreadsheet and fed to the SPSS software to find the frequencies and trend, for further analysis.

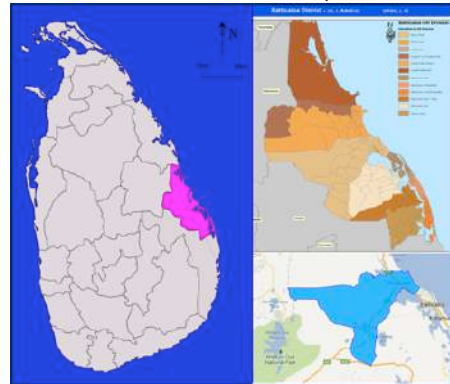


Figure 1. Study Area

Table 1: Study area

Eravur Pattu D.S Division			
AI Range	Eravur	Vantharumoolai	Karadiyanaaru
G.N Division	Eravur 04	Vantharumoolai	Karadiyanaaru
	Eravur 05	Kommathurai	Illuppachienai
	Chenkalady	Maavadivempu	Pullumalai
	Mayilambavali	Sithandi	Koppaveli
	Koduwamadu	Palacholai	Pankudaveli

**III. RESULTS AND DISCUSSION**

**A. Socioeconomic information**

**1) Age**

The result shows that majority of the farmers (48%) fall between the range of 20-30 years and 24% of the farmers fall between the ranges of 40-50 years (Figure 2). Interesting characteristic of farmers that could have either positive or negative effect on adoption of agricultural practices as observed in some adoption literature is the age of the farmer. Adesina and Baidu-Forson (1995) shared a thought on the expected effect of farmers’ age on adoption, that older farmers may have more experience in crop production and be more exposed to the potentials in modern technology than younger farmers. However they

pointed out that they could as well be more risk averse than younger farmers and have a lesser likelihood of adopting improved technology.

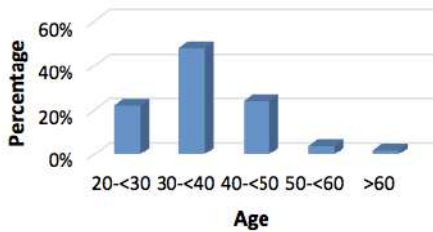


Figure 2. Age Distribution

## 2) Gender

It shows that 84% of the respondents were male while 16 % of respondents were female (Figure 3). Gender equity among the respondents who participated in this study was not achieved. Results of studies in sub-Saharan Africa have shown that male headed households have more access to land, education, and information on new technologies (Bisanda & Mwangi, 1996). There is a strong association between the gender of the household head and adoption of technological recommendations (Bisanda & Mwangi, 1996).

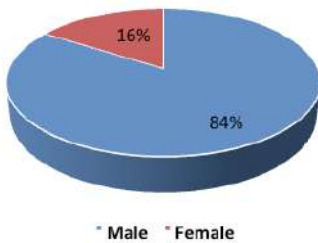


Figure 3. Gender Distribution

## 3) Educational level

Education is considered as a major determinant for generating awareness about modern agricultural practices and application of inputs while looking at the educational status of respondent, results revealed that majority (48%) of respondents have primary school educational level followed by secondary education (32%), uneducated (4%), whereas only 16% of respondents were tertiary level (Figure 4). Increased agricultural productivity depends primarily on the education of the rural farmers to understand and accept the complex scientific changes which are difficult for the illiterate rural farmer to

understand. Hence we cannot increase the productivity of the rural farmer except through the provision of adult education (Onwubuya, 2005). In most of the studies, education was found to be related to output positively and significantly. For example, in Kenya, Mook (1981) found that schooling of more than 4 years produced a higher yield than schooling below four years. In India, Chaudhri (1968) and Singh (1974) observed that level of education of farmers significantly influenced the productivity of agriculture and use of modern inputs. In Odisha, Debi (1984) and Patnaik (1985) found that level of education of farm workers was positively and significantly related to agricultural productivity.

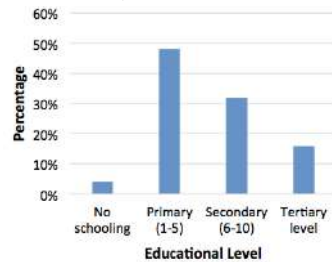


Figure 4: Educational level of farmers

## 4) Occupation

The results show that, as much as 56% of them doing farming as their major occupation and 22% of respondents were self-employed. However, having agriculture as the main occupation appears to be a disincentive to credit access. This is reflected in the low amount of credit obtained by sole farmers compared with those that have agriculture as a secondary occupation. This could be attributed to the risky nature of farming. (Awotide et al., 2015).

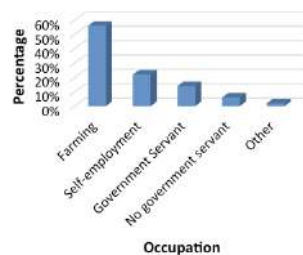


Figure 5: Occupation

5) Income level

The average total monthly income per head is above LKR 15,000. Most of them (38%) getting income between LKR 20,000-30,000. Farm income is a significant part of total income and, hence, is important for purchasing power and food security. Income level of famers is very important actor which determine the adoption of technology, education and availability of inputs.

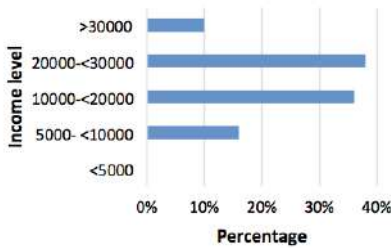


Figure 6: Income level of farmers

6) Family size

The family size of 44% respondents was five, followed by 22% of them had family size more than five members. The use of family labours on off-farm, reduces the availability of labour on the family farm that can lead to productivity loss and stagnating or declining agricultural incomes (Reardon, 1997). While, Lewis (1954) argued that in the rural area agricultural production does not decrease as a result of household member transferred to other employment, because the marginal productivity of labour in agriculture almost zero. The labour demand for farming are meet by family labour, hired labour and labour sharing arrangements. The labour sharing arrangements is a social tie which is used as a farming business transaction and a form of family labour. This implies that sources of labour for farm are causal hired labour and family labour. Most farm labour comes from family labour (Nasir, 2014).

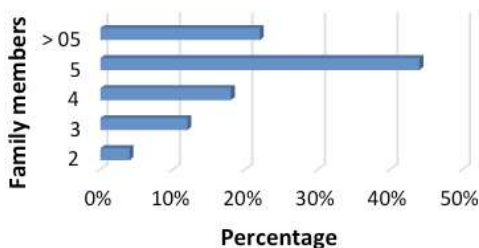


Figure 7: Family size

B. Land ownership

When considering the land ownership all farmers (100%) were having their own land in Maha season. But 58% of farmers were having their own land cultivation in Yala season. 64% of the farmers have leased land for doing cultivation in Maha season and 56% in Yala season. Land is a precious resource. According to FAO estimates, almost 80 percent of the world's undernourished people live in rural areas and most depend on agriculture, including livestock, for their livelihoods. Land ownership has the potential to increase or decrease agricultural production thus improving farmers livelihoods. Given the importance of the agricultural sector in economic growth, employment and poverty alleviation in rural areas, it is crucial that land ownership contributes to increased (or at least sustained) levels of agricultural production (FAO, 2010).

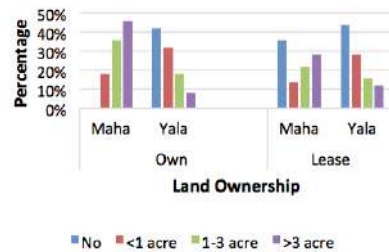


Figure 8: Land ownership

C. Nature of cultivation

82 farmers (68%) were cultivating paddy in large scale at both Maha and Yala season. Although global food (cereal) production has increased significantly as a result of adoption of agricultural innovations (improved crops varieties) and other associated technologies such as fertilizer, herbicides and pesticides (Tilman et al., 2002). Maize cultivation is very popular among arable crops farmers in Nigeria (Bamire et al., 2010) because of its high socio-economic value and importance in tackling food insecurity and poverty.

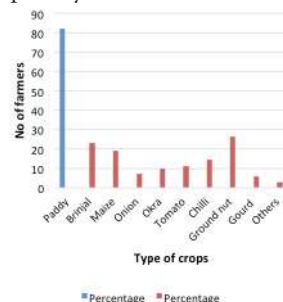
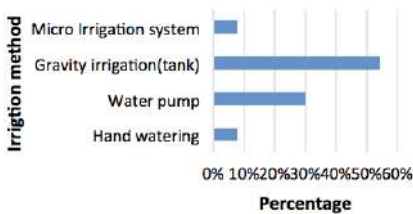


Figure 9: Nature of cultivation



**D. Irrigation method**

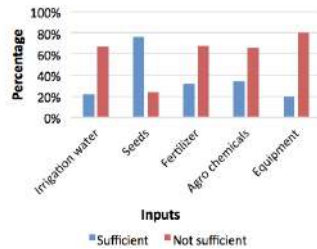
Irrigation has been described as a condition necessary for insufficient rainfall and/ or poor distribution of rainfall in agriculture producing area (Punial & Pande 1997). However, the study revealed that the method of irrigation adopted by the respondents as 54% used Gravity irrigation (tank), 30% used Water pump, and 8% used Hand watering while 8% used Micro Irrigation system. Modern irrigation technology has offered the opportunity to cultivate more land all the year round. So, a model that can adequately propel maximum food productivity, remove hunger from our society, reduce poverty and translate the dream of attaining the high agricultural productivity is presented by MWI (2002).



**Figure 10: Irrigation method**

**E. Availability of agricultural inputs**

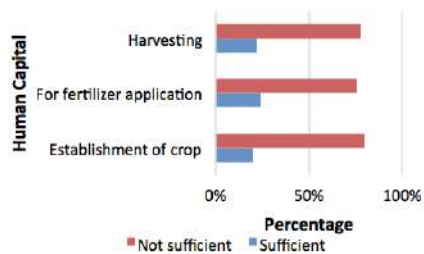
The results show that, the availability of irrigation water is not sufficient for 67% of farmers during dry seasons and seeds, fertilizer, and agro chemicals are sufficient for 76%, 32%, and 34% of farmers. In the case of equipment, only 20% of farmers were having equipment sufficiently. Agricultural marketing concerned with two aspects that is the marketing of the farm produces and marketing of farm inputs that are consumed by the farms to produce Agricultural produces. Agricultural marketing is a dominant topic in the Indian marketing literature. The main focus is on marketing of agricultural produce and that of agricultural inputs like fertilizers, pesticides, seeds and farm machineries (Jha, 1998). Sukhpal Singh (2008) stresses that agricultural inputs are at the heart of rural marketing and rural development. They support farm production which is the source of income for a very large part of rural population and create market for other consumable and durable products in rural areas.



**Figure 11: Availability of agricultural inputs**

**F. Availability of human capital**

Human capital is not sufficient to all farmers due to high labour cost. However they were managing by their family members (Figure 12). In the literature of development economics, the interaction of human capital and economic growth has been a well investigated issue. Schultz (1961) emphasizes the role of education in improving farm efficiency and in modernizing agriculture. Technical change plays a major role in increasing productivity in agriculture, which leads to high demand for human capital (Mellor 2008: 104).



**Figure 12: Availability of human capital**

**G. Membership in farmer organization**

Among all farmers, 56% of farmers were having membership in any of farmer organization especially in the Agrarian Service Centre (ASC). Farmers’ voice cannot be obtained without farmers’ organizations. In the world, for instance, there are hundreds of millions of farmers. To engage in any sensible dialogue with the rest of society, farmers need their representative organizations, the farmers’ organizations, structured from grassroots to the international level, as their legitimate voice (Bratton, 1983). This is why farmers’ movement gives a lot of importance to farmers’ organizations, organizations by farmers and for farmers, as an important pillar of today’s

society. Here is a positive causal effect from membership in a farmers' organization to overall agricultural profits. This group of income is always significant and positive. Available evidence indicates that farmer organizations can provide a mechanism to increase the total level of resources supporting agricultural development and the efficiency with which these resources are allocated at the farm level. (Bratton, 1983).

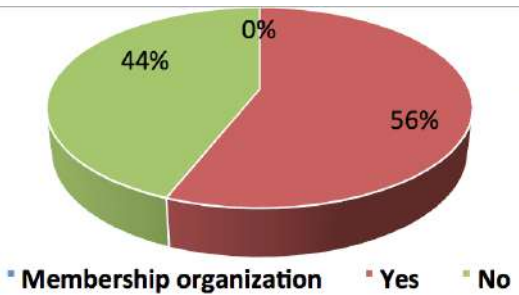


Figure 13: Membership organization

H. Extension services

On extension contact, 36% of participants had access, while 64% of participants have no extension contact. This implies that the participants had not greater chance of coming in contact with agricultural innovations which enhance productivity. Agricultural extension includes the provision of farmers with knowledge, information, experiences and technologies needed to increase and sustain productivity and for improved wellbeing and livelihoods (NRI, 2011). To ensure the performance of the agricultural sector, it is important that agricultural extension services in Tanzania are provided in the right frequency and time (Rutatora and Matee, 2001). Agricultural extension brings about changes in household food security, through education and communication in farmers attitude, knowledge and skills (Koyenikan, 2008). Agricultural extension services provide farmers with important information, such as patterns in crop prices, new seed varieties, crop management, and marketing. Exposure to such activities is intended to increase farmers' ability to optimize the use of their resources. At times even when technologies are available, smallholder farmers have no access to them (Fliegel, 1993).

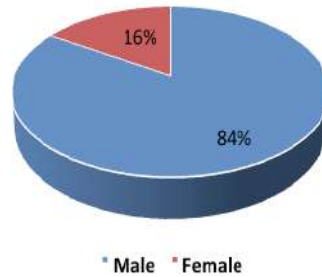


Figure 14: Extension services

I. Constraints related to farming

- Market price fluctuation for farm products.
- Limited cultivating area.
- There are no any loan facilities for vegetables cultivation
- Lack of labour during plant establishment. And lack of machineries' during harvesting.
- Poor financial condition of farmers
- There is no effective method to control the pest problem in vegetables especially in vegetable cultivation.
- Lack awareness programmed to farmers in the vegetable cultivation.
- Higher prices for inputs such as fertilizer and agro chemicals.
- Difficulty to get improved seed varieties.
- Non availability of modernized equipment.

IV. CONCLUSIONS AND RECOMMENDATIONS

Eravur Pattu area is one of the most important paddy and vegetable cultivating area in Batticaloa district. Through this study, farmers' family background, nature of cultivation, irrigation method, availability of agricultural inputs and human capital, membership in farmer organization, extension service and their constraints were studied. The age, gender, household size and total land area had a greater impact on the agricultural production in Eravur Pattu of Batticaloa District. The study shows that education level has a significant impact on the agricultural productivity of farmers in the study area. Irrigation has a tremendous positive effect on the agricultural production as remedy to drought. Provision of irrigation materials

and other inputs at subsidized rate is important for the success of the different methods employed by the farmers. Extension services were poor in this study area and availability of inputs also poor in this area. Most of the farmers were not member in any farmer organization. Therefore productivity of this area is low. Therefore farming activities can be promoted by provision subsidy schemes of agrochemicals and seed paddy on time with adequate marketing facilities. Finally this study was conclude that, agricultural productivity was poor due to lack of farmer awareness, poor education level, poor irrigation facilities, lack of available inputs. This situation should be overcome by farmer awareness programmes, provide agricultural inputs at low price by government and non-government organization.

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# EXPLORING THE AWARENESS OF WASTE DISPOSAL AND SUGGESTING FUTURE SUGGESTIONS FOR MANAGING WASTE: A CASE STUDY IN THE FACULTY OF AGRICULTURE, UNIVERSITY OF RUHUNA

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**Abstract** - Wastes are categorized into several types such as commercial waste, solid waste, construction waste and medical waste. Waste management is currently one of the most important aspects in each society that should be paid attention. In traditional concept waste has no value and is unavoidable. Growing population and rapid urbanization in each country, increases solid waste products. Basically, generated solid waste is related to the population's lifestyle and the economic situation in which the people are engaged. This research aims to study the present waste disposal methods and current program about the waste management in the Faculty of Agriculture, University of Ruhuna, Sri Lanka. The major objectives of the study were to find out the relationship between gender and area of residence with the awareness of three waste disposal methods; namely reuse, recycle and reduce. As the waste problem is a critical problem in the faculty at present, finding solutions is needed for the development of a sustainable waste management system in the faculty. All final year students (143) in the Faculty of Agriculture, University of Ruhuna were interviewed using a pre-tested

questionnaire. To analyse the collected data descriptive and correlation co-efficient analyses were used. According to the data, the highest percentage (40%) of respondents were in 25 yearage group. From the participants 67% of respondents were female and 33% were male. Out of the female population 87% of them were aware of three waste disposal methods and the awareness of the male population was 67%. Apart for the present waste disposal methods in the Faculty, students preferred to collect in one place or basket, burn and land filling. Moreover, they suggested waste separation, handing over suitable waste to collecting points, introducing a reuse system to the faculty and cattle waste for bio gas production. According to the correlation coefficient analysis, results revealed that, there is a strong, high marked association (Cramer's V 0.787) between area of residence and the awareness of three waste disposal methods, but there is no significant association between gender and awareness of waste disposal methods.

**Keywords** - commercial waste, construction waste, medical waste and solid waste, waste management

## I. INTRODUCTION

The waste problem is one of the top priority issues for most of the local authorities because they are responsible for executing waste management. Garbage collection and disposal has become an essential service in the country. So then, standards should have been improved in waste management in the country. During the recent years, a new concept regarding the construction management waste has been proposed under the name of "3R" concept, which relates to three main concepts of waste management namely reuse, recycle and reduce. Reducing means choosing and utilizing factors to decrease the produced waste value. Recycling means using waste as a resource. Reusing involves using the waste that still has useable situation. Reduce is the most important factors compared to Reuse and Recycle for minimizing the waste specially for polythene and plastic disposing. Since the encouragement to response to sustainable development, traditional waste management system has changed to a new waste management system (Shan and Tam, 2002). Therefore, the present study based on to find the current waste disposal methods and familiarizes proper disposal method conducting a survey in the Faculty of Agriculture, University of Ruhuna. Generally, University is a place of aggregate population. Around 1000 population lives at the faculty. Therefore, huge amount of waste dispose occur within one day due to concentrated population. As well as other waste such as laboratory waste, chemical waste, e-waste, agricultural waste, animal byproducts are collected within a day.

## II. METHODOLOGY

This study aims at assessing waste disposal methods in Faculty of Agriculture, University of Ruhuna with the ultimate aim of introducing a sustainable waste disposal and management system in the university premises in general. Only students were considered for this survey representing the majority of the population. Therefore, all final year students (Agri-Business and Agri-Resource management) were interviewed using a pretested questionnaire. The questionnaire contained about present waste disposal methods for each category of waste (Plastic, polythene, e-waste, wood etc.) and future suggestions. To analyse the collected data simple statistical methods were used. Moreover, data were analysed using descriptive analytical tools.

## III. RESULTS AND DISCUSSION

According to the results, Out of 143 participants, the highest percentages of respondents were in 25 age group. It was about 40% of students in Faculty. From the participant 67% of respondents were female and other rest (33%) were male. Out of the female population about 87% of them were aware of three waste disposal methods (Reduce, Reuse and Recycle) and awareness of male were 67%. By way of present waste disposal methods in Faculty, students were referred to collect in one place or basket, burn and land filling but they asked to proper waste management system within the faculty. As the best method of polythene and plastic disposal, 60% of students mentioned that reduce the usage polythene or plastic products and further they asked to adapt alternative products. To study the relationship between gender and area of resident with the awareness of three waste disposal methods, correlation co-efficient analysis was used. It is clear to that there is a strong, high marked association (Cramer's V 0.787) between area of resident and the awareness of three waste disposal methods (These relationships significant at the level of 0.05). All the respondents in different district are aware with waste disposal method except Kandy, Mulativu and Hambanthota but student in Vauniya who didn't have an awareness. It is interesting to note that gender with waste disposal methods are not significantly related.

## IV. CONCLUSION

Study reveals that majority of students were aware of the 3R system. According to the correlation coefficient analysis, results revealed that, there is a strong, high marked association between area of resident and the awareness of three waste disposal methods but there is no significant association between gender and awareness of waste disposal methods. In pursue of to the students' point of view, study recommends following recommendations in order to make a proper waste management system within the faculty. Cattle waste use for bio gas production, paper and wood can sell and it earn income, introduce proper waste separation method and composting unit should be improved to recycle and reuse.

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# EXCLUSION WITHIN EXCLUSION: GENDER STEREOTYPING OF VOCATIONAL TRAINING IN PRISON

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**Abstract** – The main objective of the study is to examine the gender differences in implementing vocational training programmes in prison. Sri Lanka has come to believe that prisoners should be economically rehabilitated and integrated to society. In this process, being gender neutral is important as the current economic system of the country requires the productive employment of both males and females to uplift the family economy which can in return avoid illegal conducts of people to a considerable degree. To make this a success, economic rehabilitation should be able to occupy the ex-prisoners in a standard livelihood minimizing the recidivism and reconviction. However, the rates of recidivism and reconviction have not been reduced making rehabilitation questionable. Female recidivism is at higher occurrence comparing to the total prisoner population. Therefore, the research examines the gender issues related with economic rehabilitation. The Magazine prison was selected as the field of study and purposive sampling was used. Qualitative and quantitative data were collected. In depth and focused group interviews and non-participant observation method were used to collect data. Data was analysed and presented in a descriptive way using narrative analysis. Through findings, it was revealed that prison overcrowding has made it hard to deliver a quality vocational training and the gender neutral access to training is limited. It has been hard to categorize prisoners according to offences or needs and all are placed in cells together. Saliently, gender stereotyping

in vocational training has limited the positive impact. Additionally, the officers are not well trained to deliver an effective and gender neutral vocational training. Society labels and discourages ex-prisoners without any trust on rehabilitation. This has become a more critical issue for female ex-prisoners. Lack of financial resources and outdated programmes are dominant in minimizing the effectiveness. Finally, the most required but least planned after care process has made the issue more critical. The policy makers, the Department of Prisons and society have been provided with recommendations through the study.

**Keywords** - Gender Neutrality, Recidivism, Reconviction, Rehabilitation

## I. INTRODUCTION

The studies that have been conducted provide an overview of current rehabilitation programmes in the Sri Lankan prison space (Athukorala, 1980). According to the studies, few vocational training programmes that are conducted in prison are batik work, plumbing, baking industry, soap making, brick making, animal husbandry, coir work, garments, shoe manufacturing and so on. Particularly, these programmes are not open for both male and female prisoners equally though they prefer and there's a clear

barrier in selecting the inmates to these programmes depending on their gender. Although Sri Lanka has introduced several rehabilitation techniques, the recidivist rate (both male and female) in Sri Lanka indicates that these techniques have not been successful (De Silva, 2008). So the main goal of rehabilitation of offenders does not seem to have been achieved.

Therefore, this study, mainly, questions “To what extent is the vocational training programmes equally effect the rehabilitation of male/ female prisoners in Sri Lanka?”

According to the progress report on training programmes for rehabilitees; issued by Department of Prisons (2012), number of activities which fall under certain categories of rehabilitation are being conducted for the benefit of prisoners in Sri Lanka. Namely, they are: education programmes, spiritual and mental development programmes, vocational training programmes, other programmes which provide awareness on particular sectors such as health and visiting important and interesting places which may help prisoners to mix with the other people.

Though there are many types of rehabilitation programmes for the prisoners in the prison space, this study concern about the above mentioned problem. The main objective is to examine the gender differences in implementing vocational training programmes in prison since the vocational training programmes are more effective and useful to the prisoners disregarding their gender not only when they are imprisoned but also when they complete their imprisonment period and come to the general stream of the society back. But, these vocational training programmes require a considerable attention to be more effective because of the inadequacies mentioned above.

## II. METHODOLOGY

The study is exploratory in nature. The research was primarily designed as a cross-sectional study because it aimed at finding out the prevailing effectiveness of the vocational training programmes for prisoners gender wise. Since it is impossible to study the whole study population, a representative sample of 25 respondents was selected based on purposive sampling method as the main focus was to study the recidivists who received vocational training at the first imprisonment. Sample was contained of recidivists who received vocational training at the first imprisonment and prisoners on first conviction who are

being received the vocational training in the Welikada prison space. Each group consisted of 10 respondents representing both male and female prisoners equally. Both groups were selected based on their common characteristic of receiving vocational training which is directly related to the study. It is noteworthy that none of the ex-prisoners who received vocational training and didn't become recidivists could be included to the sample due to the absence of a proper after care system that can be utilized to contact them. Except for inmates, five other respondents were selected including welfare officers, jailors and vocational trainers.

Primary and secondary sources which are comprised with both qualitative and quantitative data were collected through sample and secondary sources available. Above mentioned sample was used to collect primary data for the study while secondary data was mainly collected from the prison reports and ministerial records. Here, secondary data was collected from the Prison Headquarters, Welfare Section of the Welikada Prison, Department of Prisons and from the Ministry of Rehabilitation and Prison Reforms. In addition, Centre for the Studies of Human Rights (CSHR) of Colombo University was used to collect secondary data. Through these Primary and secondary data sources, both qualitative and quantitative data required for the research were found.

Further, to collect primary data from the sample, In-depth Interviews, focused group interviews and Non-participant Observation Method were used in this study. These methods were used to collect data as the study focused more on qualitative data and also a more explanatory and depth understanding could be achieved through these methods. In-depth and focused group interviews were used as data collection techniques and data was analysed accordingly.

## III. RESULTS AND DISCUSSION

Simply, rehabilitating prisoners refers to all the activities that influence in renegotiating his/her identity. When a person is convicted of a crime and enters a prison, he/she is entering a closed institution, an institution much more restricted than the society. One of the major tasks of this institution is to rehabilitate the prisoner or in other words to help him/her understand what went wrong in his/her behaviour and to help them to become healthier and productive citizen in the future (Martin, 1962). In order to achieve this task, the prison officials should educate them,



help in the process of developing social relationships, look into their health issues, food and sanitation, give them counselling, give them vocational training and assist them in finding employment after leaving the prison. To achieve this purpose, in the prison system, there are many rehabilitation programmes under many themes. Some of them are educational rehabilitation, religious rehabilitation, health rehabilitation, economic rehabilitation, social rehabilitation and so on.

With reference to the sustainability of this process of rehabilitation, there should be an assurance that ex-prisoners will not become recidivists. In this case, there should be a social commitment for the rehabilitated ex-prisoners when they are released. Specially, female prisoners should receive more carefully planned aftercare strategy as they are more vulnerable with the existing social attitudes to be discriminated not just as they are ex-prisoners but as they are 'female' ex-prisoners. Commonly, their role should be shifted from "ex-prisoner" to "employee" which give them a social status and acceptance. It indirectly gives them a responsibility to confirm social norms, values and laws. For this, when a person is imprisoned, there should be an economic rehabilitation programmes. The study, because of this importance, mainly focuses on the vocational training which provides economic rehabilitation.

It was obvious that technically, many areas that should be taken into consideration have been already focused. But still, when studying the effectiveness of them, it was noticeable that there are many issues in those programmes interrupting the effectiveness of those programmes. More importantly, prejudices on gender roles are highly interruptive in implementing vocational trainings. For instance, when vocational trainings are delivered, male prisoners have access to number of programmes such as Masonry, Carpentry, Electrical wiring, Plumbing, House wiring, Coir work, Baking industry etc. Though these are not recommended to segregate gender wise, females are delivered just a handful of trainings compared to males in practice such as Sewing, Beauty culture, Garments, Weaving etc. which are stereotyped as 'females' work. This limitation restricts female prisoners from learning something that is marketable and economically employable. The attitude of implementers is highly influential here. They believe that women should be taught something that is helpful to their household activities. It can be further recognized as a lack of awareness given to the officials who deliver the services and trainings. This practice represents the conservative

gender role expectations which can nullify the expected effectiveness of vocational training.

On the other hand, the attitude of the male and female prisoners towards the vocational training that is received is completely contrast. Males are more positive towards the training when compared to female inmates. Male inmates consider the training as a good opportunity to learn an occupation whereas female inmates consider it as a way of time passing and a help to make the domestic work easy once they are released. Women themselves have come to believe that they are useful only in domestic affairs because of the highly stereotyped socialization process (Bhasin, 1993). This can be analysed as an internalization of the general concept of gender roles. Female inmates less consider themselves as economically important members of the family. Therefore, it can be concluded that female prisoners have excluded themselves from the vocational training programme. Somehow, negative attitudes of the stakeholders towards rehabilitation has excluded many those who are in need for rehabilitation.

Prison overcrowding has further reduced the effectiveness as a proper segregation cannot be done. Since the prison population is unprecedentedly high and still keep climbing up, gender sensitive and well-timed segregation cannot be made. More specifically, female inmate population, being the minority compared to male inmate population, has forgotten from the planning and implementation process which again exclude them from an effective rehabilitation. Apart from these main findings that directly influence to gender discrimination, lack of financial and technical arrangements to cater the needs of both male and female prisoners has reduced the effectiveness dramatically. Many vocational training programmes are outdated and cannot address the modern market oriented economic labour needs. Particularly, it doesn't go parallel with the modern labour force trends where women also actively participate in family economy. Further, the officers are not trained to follow new techniques to make the programmes more effective. Ultimately, financial allocations are not sufficient to make such progressive changes in prison.

#### IV. CONCLUSION

Prison system is currently conducting many rehabilitation programmes. But, the main focus of them has shifted away from the mission, vision and the motto of the Department of Prisons. Though it is supposed to provide custody, care and correction of the prisoners through imprisonment

without any discrimination, what mostly happens is only custody and care. Prevailing rehabilitation programmes have been introduced to the prison system with the purpose of correction and reintegrating prisoners into the normal society as law abiding citizens who spend decent lives. But unfortunately, even the rehabilitation programmes treat males and females in a discriminatory manner which has become an exclusion within an excluded setting. It makes the vocational training and many other rehabilitation programmes ineffective for the correction process. It was long time ago that the prison system turned its aim from punishment to correction. Therefore, effectiveness of the vocational training as well as the other correctional processes should be reconsidered and immediate steps should be taken to reconstruct them as effective, gender sensitive programmes which contribute to the correction of the prisoners.

By looking at the issues that are prevailing, it can be concluded that the state level mediation is required to address the system related issues of vocational training

programmes. Apart from that, it is important to address the stereotyped attitudes of both inmates and officers as to reduce the limitations that constraint the effectiveness. Even the general society should take part in making the process a success by avoiding labelling the ex-prisoners disregarding their gender.

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# KEY ACTORS IN AGENDA- SETTING ON LGBTQ RIGHTS: POSITIVE AND NEGATIVE ROLE

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## Abstract -

### Introduction

We are in an era that generally accepts that every human being is born free and deserves equal rights to live their lives as they wish with freedom. But this is an almost unrealistic dream for LGBTQ groups all over the world. This is because LGBTQ rights are still not sufficiently addressed within the international human rights agenda.

In the last few decades, international customary law concepts such as non-discrimination and freedom have become more prominent and visible in the international human rights agenda. This environment has motivated civil society actors, international organizations and states, to respect and ensure human rights, and they have also engaged in the process setting the international human rights agenda. This paper discusses the role of the key actors that propel the process of inclusion of LGBTQ rights in the international agenda.

### Objectives of the study

This research paper has two main objectives:

- (1). To examine the role of relevant actors in international agenda setting process vis-a-vis LGBTQ rights.
- (2). To identify the challenges faced by advocates of LGBTQ rights in making these part of the international human rights agenda.

### Methods and sources

Method of this research will be based on non-doctrinal legal research methods (socio- legal research). Non-doctrinal legal research method is basically analysis of the formation or setting of the law with regard to three factors. These three factors are: “the legislative processes, inquiring into the initiation and formalization of law, the forces, factors or pressure groups that played significant role in its making and with what objectives” (Vibhute and Aynalem 2009 p.88). Indeed, socio legal approach mentions how social factors impact upon the formation of law and human rights.

I selected this method because, I also focus on the factors that keep sexual minority rights out of the international human rights agenda, and actors who play major role in agenda setting. This method is helps to understand how social factors affect agenda setting with regard to LGBTQ rights.

The primary sources that used for this study include international human rights documents such as Universal Declaration of Human Rights (UDHR), UN charter, other relevant UN resolutions, International Covenant on Civil and political Rights (ICCPR), Convention on the Elimination of All Forms Of Discrimination against Women(CEDAW), Yogyakarta principles, and advocacy and policy documents regarding LGBTQ rights. The secondary sources include books, journal articles, and research papers and write ups about LGBTQ rights.

### Research puzzle

My main research question is: Why have LGBTQ rights not featured adequately on the international human rights agenda? There are two hypotheses that are used in this research. The first one is that the lack of clarity about sexual minority rights has been a barrier to its inclusion in international human rights agenda. Second hypothesis is that contrary to the generally positive roles attributed to civil society actors, anti- LGBTQ rights civil society organizations have negatively affected the inclusion of sexual minority rights in international human rights agenda.

### Discussion

The global civil society plays a major role in shaping human rights agenda, because they are directly involved in framing issues and decision making processes. "According to Risse (2002) the fact that Non-Governmental Organizations are primarily active within the agenda formation of global politics is not surprising as they provide moral authority" (Lewin and Meyer 2002). International organizations have the main responsibility to develop international human rights policy and standards, which can also be used to monitor states. International Organizations such as the UN works as a platform for states to discuss international issues, but they can also be autonomous actors in pushing forward the human rights agenda. Furthermore, states are major actors who can translate the human rights agenda into reality through their positive behavior. But all these actors play both negative and positive roles in the agenda setting process because while some push LGBTQ rights into the human rights agenda, others block the same.

### Conclusion

Civil society actors tend to play more of a negative rather than positive role when it comes to international agenda setting in relation to LGBTQ rights. Usually, NGOs are seen to play a positive role regarding issues such as environment, health and human rights. They do a remarkable task in addressing problems in the world. In the case of LGBTQ rights, there are few actors such as Human Rights Watch and Amnesty international that play a crucial supportive role in agenda setting. But there are many other actors who, with their beliefs on religion, family, marriage and reproduction, block any progress in sexual minority rights. Even the UN does not provide enough space for LGBTQ advocates to negotiate the issues that should be addressed in the human rights agenda. In certain instances, the UN has also cancelled some of LGBTQ organizations' UN consultative status.

**Keywords** - LGBTQ rights, International human rights, agenda settings

## I. INTRODUCTION

"Human rights are rights inherent to all human beings, whatever our nationality, place of residence, sex, national or ethnic origin, color, religion, language, or any other status. We are all equally entitled to our human rights without discrimination. These rights are all interrelated, interdependent and indivisible." - (United Nations 2012).

Human Rights have give dignity, freedom, liberty and equality to every human being. Indeed, human rights are the values and norms which always protect human beings from severe political, social and economic trauma. The above mentioned UN definition also mentions that human rights are applicable for everyone without any discrimination. Sexuality and sexual orientation are a major part of human identity and play an important role in human identity and people's private lives. Therefore, sexual minorities should not be discriminated based on sexual orientation or gender identity. Indeed, international human rights agenda, which seeks to ensure everyone's human rights, should take this issue into account.

### A. Conceptual Framework

#### 1. Understanding "LGBTQ"s

There are essential terms with regard to LGBTQ rights, which should understood at the outset. According to the 2007 Yogyakarta Principles, Lesbian, Gay, Bisexual Transgender and Queer people are included in the category of "LGBTQ". Therefore, after this explanation I would be using the term "LGBTQ" for them.

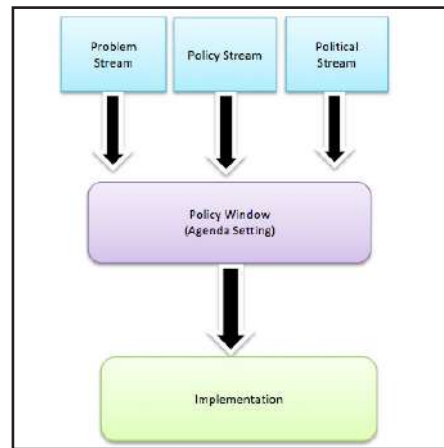
Furthermore, LGBTQ community face discrimination which based on sexual orientation. Therefore understanding the difference between sex and sexual orientation is important. "Sex is the state of being male or female" (Merriam Webster 2017). But "sexual orientation is understood to refer to each person's capacity for profound emotional, affectional and sexual attraction to, and intimate and sexual relations with, individuals of a different gender or the same gender or more than one gender" (Yogyakarta Principles 2007).

## II.METHODOLOGY AND EXPERIMENTAL DESIGN

### 1. Agenda Setting

In this research, methodology and experimental design that I used to answer the research question is primarily based on agenda setting process, specifically John W. Kingdon's agenda setting model (1995). "Agenda setting results in a selection between diverse problems and issues. It is a process of structuring the policy issue regarding potential strategies and instruments that shape the development of a policy in the subsequent stage of a policy cycle"(Fischer and Miller et al. 2007, p. 62). I choose to use agenda setting because of three reasons. First, agenda setting mostly takes the issues which do not get enough attention in the public and private sphere, and discusses those problems. LGBTQ rights is also a hidden and invisible human rights issue which does not get enough attention in any sphere. Second reason is that it gives us insights into the role of relevant actors. Third reason is that it explains the agenda setting process.

There are several models for agenda setting, but I used John W. Kingdon's agenda setting model(1995) in this research because it explains how issues are brought in to the political agenda, and how solutions are developed to address identified issues (Furlong 2003). Kingdon suggests three most important streams for agenda setting. Those are: problem stream, policy stream and political stream (Swiebel 2009). The problem stream defines the issue that is to be placed on the agenda. It describes the salient and unrevealed issues that need to be presented to the public. The policy stream is about developing policy which can address the issues and the solutions given by experts and policy makers. The political stream is "motivations and justifications for political action, following from political events, changes in political climate, etc." ( Swiebel 2009 p21). Basically political stream includes the institutions, governments and policymakers and politicians which have responsibility for making policies.



**Figure 01- John W. Kingdon's agenda setting model**

In this research, I used Kingdon's model for analysis of the LGBT rights agenda setting process. Specifically, I examined how key actors play both positive and negative roles with regard to problem, policy and political streams.

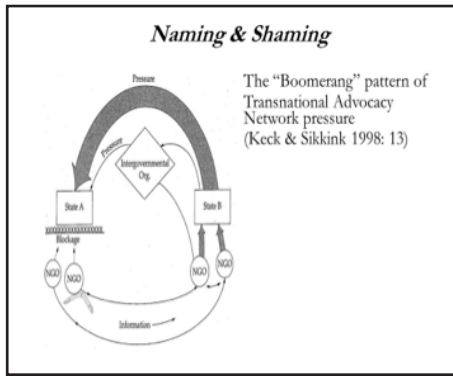
## III.DISCUSSION

As mentioned in the part II, I used John W. Kingdon's agenda setting model for analysis of the role of key actors in problem stream, policy stream and political stream of LGBTQ rights agenda setting. I will now apply the Kingdon's agenda-setting model on the subject of LGBTQ rights.

### A. Role of Civil Society Actors and International organization in the Problem Stream

Civil society actors as well as international organizations play major role in problem stream agenda setting. Some play a positive role by seeking human rights for LGBTQ while others play a negative role by blocking the promotion of LGBTQ rights, roles.

NGOs raise the issue that international organizations (IO) should take into their mandate and, after such motivation IOs contributing to setting the global agenda (Joachim 2007 p 7). Keck and Sikkink (1998) present the 'boomerang model' whereby when states block domestic NGOs access to policy settings, those NGOs provide information about the situation to international NGOs, other states and IGOs who then put pressure on the original state regarding that particular policy. Therefore, the support of civil society actors like NGOs and IGOs is essential for problem stream of agenda setting.



**Figure 02- Keck and Sikkink's 'Boomerang model' (1998)**

In the problem stream, civil society actors and IOs frame the issue area. First, they investigate the current situation of LGBTQ's human rights violations and collect the relevant data. As a second step, they issue reports regarding the current issues. These reports raise awareness of the global community by highlighting the essential need for a stable LGBTQ rights agenda. Further, they organize international conferences as a third step of this problem stream, and discuss how to push the international agenda for LGBT rights.

Under the first step, international NGOs such as Amnesty International (AI), Human Rights Watch (HRW), Actionaid individually collect the data about LGBTQ violations. Indeed, they first try to include LGBTQ issue into their own agenda. For example, "In 1991, Amnesty International (AI) became the first mainstream human rights organization to include sexual minorities in its definition of political prisoners" (Narayan 2012, p29). Then they prepare reports using the data they collect. For example, AI issued a report "Crimes of Hate, Conspiracy of Silence" which highlights the hate crimes and discrimination against LGBTQ people (Lewin and Meyer 2002). In 2013, HRW issued a world report on tortures of sexual minorities in the world. This report revealed the discriminatory practices against homosexuals all over the world, and it strongly recommended to responsible international organizations like the UN to take essential monitoring actions to ensure LGBTQ rights (Human Rights Watch 2013). These reports are important to identify the crucial issue areas as well as to raise the awareness of international policymakers regarding LGBTQ issues.

These reports highlight the need for global negotiations to discuss these issues, and at this stage also NGOs and IOs are involved. For example, the World Conference on Human Rights in Vienna (1993), the International Conference on Population and Development in Cairo (1994) and the World Conference on Women in Beijing (1995) were very important to LGBT civil society activists because these raised international awareness regarding LGBTQ rights (Mertus 2007). Specific to the LGBTQ agenda, the UN called a landmark ministers' meeting on LGBTQ rights in September 2013 where they discussed how to combat discrimination against LGBTQs. HRW, International Gay and Lesbian Human Rights Commission, and a large number of cross regional groups from Argentina, European Union, New Zealand, France, Israel, and Japan contributed to these discussions (Human Rights Watch 2013). Earlier, in 2001, the General Assembly Special Session on HIV/AIDS also talked about sexual orientation with regard to gay people. These types of negotiations gave directions to policymakers to set the sexual minority rights agenda (UNHCR 1993).

**B. Negative role of civil society actors.**

There are two sets of actors who play the negative role with regard to LGBT agenda. One group is based on social, cultural and moral values related to religious beliefs, and the other group is based on traditional values of family, marriage and reproduction.

The first group includes actors such as the "Baptist-Burqa" network, which consists of anti-gay Muslim groups and anti-gay Christian groups that work against homosexuality. They have a consultative status with the UN, and in the 1994 Cairo conference they blocked the development of proposal that sought to give support to homosexuality (Bob 2011, p.41). Earlier, the World Council of Church put barriers to the negotiation of lesbian issues at the 1985 Nairobi conference (Bob 2011, p.41). The Alliance Defending Freedom (ADF) is also promoting homophobia in Europe, Canada, and Latin America, but was able to get special consultative status at the UN in 2010 (Southern Poverty Law Center 2013). It has argued that homosexuality negatively impacts on religious freedom and should, therefore, not be taken up in the UN agenda.

The second group includes actors like the Coalition for Women and the Family, which at the 1995 World Conference on Women, accused "lesbian delegates for their direct attack on the values, cultures, traditions and religious beliefs of the vast majority of the world's

population”(Bob 2012 p 34). In September 2013, the World Congress of Families (WCF) organized a conference along with other anti-gay activists in Russia to give their support to Vladimir Putin’s anti-gay activities (Tashan 2014). These groups believe in the traditional heterosexual notion of family and marriage, and therefore block the LGBT agenda.

### **C. Role of Civil Society Actors and International organization in the policy stream of agenda setting**

International organizations and civil society actors together play the main role in the policy stream. They have the responsibility to evaluate human rights issues and produce the policy which can address the problematic situation.

The United Nations is the major international organization, which set the policy for international human rights agenda. We can see the gradual development of UN agenda with regards to LGBTQ rights. In 1993, the UNHRC gave equal refugee status to LGBTQ people (UNHRC 1993). In 2007, United Nations Educational, Scientific and Cultural Organization (UNESCO) issued an important report about the UN’s role in promoting LGBT rights. According to this report, in the last few years most UN agencies and their special rapporteurs have been concerned about discrimination against LGBTs and sexual minority rights (UNESCO 2007). It says, for example, “The Special Representative of the Secretary-General on the situation of human rights defenders has been assiduous in condemning the intimidations of and attacks on lesbian, gay, bisexual, transgender and intersex activists” (UNESCO 2007).

In 2006, for the first time in human rights agenda, the term “sexual minority” was defined in Yogyakarta Principles, which especially gives protection to LGBTs. In the year 2008, the UN General Assembly issued an important Statement on Human Rights, Sexual Orientation and Gender Identity (UNGAM 2008). This statement mentioned that the principle of universality of human rights can apply to sexual minorities also without any discrimination. In March 2011, the UN Human Rights Council (UNHRC) issued a statement named “Ending Acts of Violence and Related Human Rights Violations Based on Sexual Orientation and Gender Identity”. This statement mentioned that states should not allow the spread of violence and discrimination based on sexual orientation and gender identity (UNHRC 2011). In June 2011, the UNHRC again issued a resolution about human

rights violation based on sexual orientation and gender identity (UNHRC 2011).

However, we can also see some failures within the UN agenda setting process on sexual minority rights. For example, in 2003, Brazil tried to issue a resolution in the UN Human Rights Council on sexual minority rights. But African countries and OIC blocked this resolution (AWID 2013). Further, the UN sometimes does not give enough space to talk about LGBTQ issues within their human rights agenda. For example, in 2006 the UN Economic and Social Council (ECOSOC) refused to allow LGBTQ advocates such as ILGA (International Lesbian and Gay Association) and the Danish Association of Gays and Lesbians into joint discussion at the UN. (Mark 2006).

Some LGBTQ right organizations are able to engage with IO policy negotiations due to their UN consultative status. Therefore, they are directly involved in UN policy making processes on LGBTQ issues. For example, the International Gay and Lesbian Human Rights Commission (IGLHRC), International Lesbian and Gay Association (ILGA), International have the consultative status, and through their suggestions and recommendations, they push the sexual minority rights agenda. For example, ARC International they gave their suggestions and recommendations to produce the Yogyakarta principles, and continue to give their support to UN to protect LGBT rights all over the world (ARC International 2013). Indeed, ARC successfully works with LGBT NGOs to bring international support for LGBT agenda setting process.

### **D. Political stream of agenda setting and the role of States and International Organizations**

In the political stream of agenda setting, states and IOs play the major role. States can support as well as oppose LGBTQ rights processes within the international agenda. Powerful IOs such as the UN and the European Union can address LGBTQ issues within their mandate, and they can influence their member states to sign and ratify the human rights treaty bodies with regards to human rights. But it is to be noted that in the case of LGBTQ rights, there is no human rights mechanism as yet with enforcement power. A large number of states in the world do not recognize LGBTQ rights. Homosexuality is a crime in seventysix countries and is penalized by death sentence in countries like Iran and Saudi Arabia (United Nations 2011). Very few states such as South Africa, France, Nepal, the United Kingdom and some states in the USA respect

homosexuality. Most of the Muslim countries are practicing Sharia law, which criminalizes homosexual behavior. Christian countries like the Vatican also block LGBT rights agenda. The Vatican has a “permanent observer” status at the UN, and they block the promotion of international sexual minority rights agenda in the UN (The Atlantic 2014). Most of the African countries also oppose LGBT rights. Moreover, “dominant regional groups and political blocs use their collective weight to promote common objectives” (Freedman 2013). For example, the organizations of Islamic Cooperation (OIC), most of Asian and Middle East countries have shared objectives, which oppose LGBT rights.

Mostly, it is states that can contribute to the political agenda setting, by using their UN general Assembly vote with regard to adoption of resolutions and declarations on LGBT rights. But they have not been very supportive. A report by Ella J.J. Weggen’s research (2009) suggests that countries generally do not contribute positively to the political agenda of LGBT rights. According to this report, in 2003, most European member countries supported the Brazilian resolution about LGBTQ rights at UNHRC, mentioned earlier, but Pakistan opposed it saying that this was an insult to Muslims. In 2007, 66 countries signed the Yogyakarta Principles but there are many countries that are yet to sign this document. In 2008, the UN General Assembly issued a declaration supporting LGBTs but, most African, Islamic and Latin American countries did not support to it.

### **E. Lack of clarity regarding LGBTQ rights as human rights**

In the last few decades, there have been controversial debates on LGBTQ rights in the international human rights agenda. Mostly, these debates relate to the recognition of LGBTQ rights as human rights. For example, there is a debate between those who argue that there is an essential need to separate and specify human rights for sexual minorities and those who claim that there is no need for separate human rights for sexual minorities since they are covered by existing human rights mechanisms. Due to such debates, discussed below, we see the lack of clarity and limited progress regarding LGBTQ rights on international human rights agenda.

### **1. Heteronormativity of the international human rights agenda**

The main international treaty bodies in the human rights regime do not mention the rights of sexual minorities, and

present heterosexual relations as the norm. For example, article 16 of the 1948 UDHR makes the following reference to the right of marriage and right to have a family, “Men and women of full age, without any limitation due to race, nationality or religion, have the right to marry and to found a family. They are entitled to equal rights as to marriage, during marriage and at its dissolution.” Article 16 promotes only heterosexual marriage and traditional family because limitations due to sexual orientation are not mentioned. Therefore, international human rights mechanisms are predominantly heteronormative because these promote heterosexual notion of family and marriage rights only.

### **2. Definitional debates and lack of clarity regarding the concepts relevant to LGBTQ rights**

One major problem which has affected discussions on LGBTQ rights in the international human rights agenda is definitional debates on LGBTQ rights. LGBTQ rights are based on “sexual orientation” and “gender identity”, but until recently we do not see any formal efforts to define LGBTQ rights within the international human rights agenda. In 2007, for the first time in the history of international human rights, the Yogyakarta principles defined the rights of LGBTQs’ based on sexual orientation and gender identity. But Yogyakarta principles also do not clearly define these sexual minorities. For example, it simply defines LGBT groups as sexual minorities. But it does not clearly mention the difference between the Lesbian, Gay, Bisexual and Transgender people. Further, the Yogyakarta principles do not consider intersex people and asexual people (people who are not attracted to any gender) as sexual minorities.

Further, international human rights mechanisms have not also clearly described the issues of sexual minorities. The focus has been limited to issues regarding sexual relationships only. But in reality, lesbian, gay, bisexual or transgender people do not only struggle due to sexual relationship with same sex person, but also have to struggle in their everyday lives. There should be greater understanding of “gender identity” as well as “sexual identity”. For example, the “sexual identity” of transgender people, who are not identified as being of “male” or “female” gender by birth, and have been described as the “Third Gender” (Stryker and Whittle et al. 2006 p 666). In a society that generally identifies only two genders, transgender people suffer a lot of difficulties. For example, in public places, boys are expected to go to “male”



washrooms and girls to “female” washrooms. Each and everything is socially constructed. Indeed, most official documents ask for information on biological gender, but the forms have only two gender categories – male and female, neither of which applies to transgender people.

### 3. Putting LGBTIQ people in to one Umbrella concept call “sexual minorities”

The sexual diversity of lesbian, gay, bisexual, transgender, intersex and queer people is also not explored in the international human rights agenda. The UN has simply incorporated all of them under one term “sexual minorities”. According to Alice Miller, “this umbrella term has been used by UN experts and mechanisms to deal with issues of discrimination, exclusion and stigmatization, [but] it is unclear what groups are included as sexual minorities and how the status is determined” (International Commission of Jurist 2009, p.22-23). Indeed, Miller mentioned that these types of ambiguous definitions are controversial when categorizing human rights abuses regarding sexual orientation and gender identity (International Commission of Jurist 2009, p.22-23). Some lesbian and gay rights movement and organizations do not like to give the membership to bisexual, intersex and transgender groups, because of this controversial debate. This also makes international human rights agenda weak regarding LGBT rights.

### 4. The debate about “ Human Rights For All”

International human rights agenda mentions “human rights for all” (UN 1996). It is argued that sexual minorities are also included as human beings, and there is no need for separate human rights for them. However, generally, international human rights treaty bodies have stable fixed standards based on “1950s and 1960s attitudes”, when there were no active gay rights movement in the world (Donnelly 1999 p20). Therefore, treaty bodies such as UDHR, ICCPR, ICESCR do not address the issue of sexual minority rights that should be based on sexual orientation and gender identity. Article 2 of UDHR, ICCPR and ICESCR mention that no one should be discriminated against because of their “sex” but, as discussed in the first chapter, the notion of “sex” is different from the “sexual orientation”. So, the problem is that general human rights treaty bodies do not mention “sexual orientation” as “prohibited ground” (Donnelly 1999 p20).

### 5. Contestation between sexual minority rights, and rights of religious freedom and cultural rights

Finally, some anti- LGBT groups argue that sexual minority rights goes against rights of religious freedom and cultural rights. For example, ICCPR article 18(3) mentions that, “Freedom to manifest one’s religion or beliefs may be subject only to such limitations as are prescribed by law and are necessary to protect public safety, order, health, or morals or fundamental rights and freedoms of others.” This article can be used to argue that homosexual behavior negatively impacts upon ‘public safety, health and moral values in the society’. Homosexuality has been connected to spread of HIV/AIDS and, as discussed earlier, critics see it to be against the religious beliefs and the moral values of society.

## IV.CONCLUSION

The main aim of this research was to examine the role of key actors in agenda setting on LGBTQ rights. In this respect, two hypotheses were examined. First hypothesis examined the positive and negative roles of civil society actors in relation to sexual minority rights in the international human rights regime. Second one analysed barriers such as the debate on whether sexual minorities are human rights. In conclusion, I summarize the key findings of and make some recommendations about pushing forward the agenda of LGBTQ rights.

Civil society actors, international organizations and states are the key players in sexual minority rights agenda setting. They can contribute to all three streams – problem, policy and political – of the agenda-setting model proposed by Klingdon. And, as discussed in this Paper, they play both positive and negative roles. Mostly, LGBTQ friendly NGOs create the issue frame and make the global community aware of the issues. Indeed, whenever states reject LGBTQ rights, NGOs are give this information to international organizations, pushing them to handle the situation. On the other hand anti-LGBT NGOs put barriers to this process. International organizations mostly play a key role in the policy stream in agenda setting. But they do not address LGBTQ rights agenda sufficiently.

I found that civil society actors tend to play more of a negative rather than positive role when it comes to international agenda setting in relation to sexual minority rights. Usually, NGOs are seen to play a positive role regarding issues such as environment, health and human

rights. They do a remarkable task in addressing problems in the world. In the case of sexual minority rights, there are few actors such as Human Rights Watch and Amnesty international that play a crucial supportive role in agenda setting. But there are many other actors who, with their beliefs on religion, family, marriage and reproduction, block any progress in sexual minority rights. Even the UN does not provide enough space for LGBT advocates to negotiate the issues that should be addressed in the human rights agenda. In certain instances, the UN has also cancelled some of LGBT organizations' UN consultative status.

Most of the international organizations do not include human rights with regard to sexual orientation in their agenda. States can make human rights agenda a success or a failure. They are directly involved in the political stream of the agenda setting process through their votes. In these various ways, the actions of all three set of actors impacts upon the agenda setting on LGBTQ rights.

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# IMPACT OF DIFFERENT TRAFFIC MOVEMENTS ON REVENUE OF BANDARANAIKE INTERNATIONAL AIRPORT

Aircraft Movements, Passenger Movements & Visitor Movements

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**Abstract** - This research scrutinizes the impact of International aircraft movements, International passenger movements and visitor movements on the revenue of Bandaranaike International Airport. Revenue management is a potential burden to an airport with resource utilization and profitability targets. The research initially found the impact of the above-mentioned movements of the airport revenue and ultimately discussed the suggestions to improve the present situation as well as to find the new avenues of revenue to profit maximization. As a method to identify this impact, secondary data were used for five years from 2011 to 2015. This includes the monthly data of airport gross revenue, total of international aircraft and passenger and visitor movements. Multiple regression analysis was used to find the impact and has proven this model with different statistical measurements. The study found the positive

relationship between aircraft movements and passenger movements on airport revenue. Tests verified that there was no significant impact from the visitor movements. The Research is aimed at providing suggestions to improve both significant and insignificant traffic movements in order to facilitate the future requirements of the airport.

**Keywords** - Bandaranaike International Airport, Total gross revenue, International passenger movements, International aircraft movements, Visitor movements, Multiple regression analysis.

## I. INTRODUCTION

Airports play a vital role in globalization by linking municipalities and people around the world. This emphasizes that connecting communities and businesses

with the world to cater the demand. These airports are a vital catalyst to encourage the financial activities by improving international trade, commerce and tourism. This is not only for the success of a region but to an entire nation. Airports contribute to the positive influences of the tourism sector as more money will flow into the economy with the increase of airport users. With the availability of employment opportunities, it increases the standard living of people. Hence Gross Domestic Production (GDP) increases and provide a financial advantage to the economy. This emphasizes that the aviation industry plays a paramount role in promoting tourism.

The existence of a vigorous and an effective aviation industry is essential for an island akin Sri Lanka. This is the main mode of transportation of passenger and sensitive cargo to the entire world. Civil aviation industry plays a key role to make the most attractive country in the South East Asia region in terms of commercial and tourism aspects.

The birth of the Aviation history was commenced in Sri Lanka on September 12, 1911 (Jayawardhana, 2012, p. 33). That instance onwards, aviation in Sri Lanka has developed towards to a new era of aviation. The reason was due to considering the extensive advances in the commercial aviation. The main task of Civil Aviation Authority is to oversee activities which promote safety and security of civil aviation in accordance with the International Civil Aviation Organization (ICAO) (CAASL, 2016). Airport and Aviation Services (Sri Lanka) Limited (AASL) was established to provide the services such as air navigation, airport management, development and maintenance of civil airports.

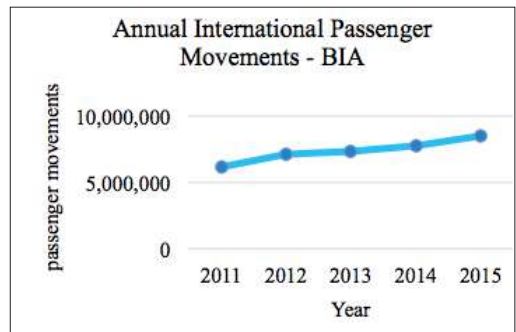
Aviation of Sri Lanka comprise with fourteen aerodromes including two International Airports Bandaranaike International Airport (BIA) & Mattala Rajapaksa International Airport (MRIA) (CAASL, 2016). Colombo Airport (RMA) was the only International Airport to operate Jet operations in Sri Lanka until the establishment of the BIA. Among the International Airports BIA plays a major role and contribute to the higher revenue for the Aviation industry in Sri Lanka since can be referred as the Gateway for the economy.

At the beginning of BIA, it handled at about 1.5 million passenger capacity per annum and at it has exceeded 6 million per annum handling capacity in 2005 (MOCA, 2012, p. 24) . According to the AASL (2014) capacities available are;

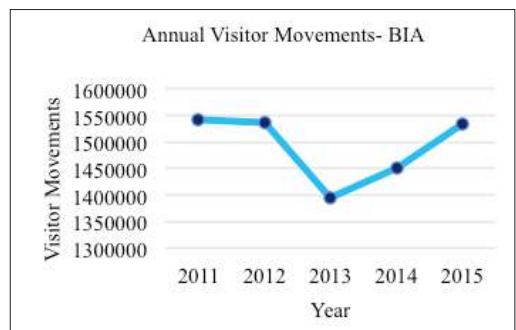
- Bridge bays- 8
- Non-bridge bays - 17
- Bridge boarding gates -8
- Remote boarding gates -4

Although the passenger capacity increased in the past period, buildings and infrastructure have not been developed proportionately. This emphasizes that more revenue can be generated by expanding the current infrastructure.

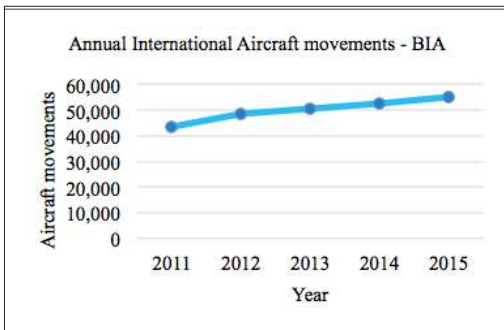
In year 2015, Air Transport sector has demonstrated an improvement in Sri Lanka. Total passenger movements of the BIA recorded 8.5 million (CAASL, 2016).



**Figure 1: Annual International Passenger Movements- BIA (2011-2015)**  
**Source: Statistical Information-AASL**



**Figure 2: Annual Visitor Movements - BIA (2011-2015)**  
**Source: Statistical Information-AASL**

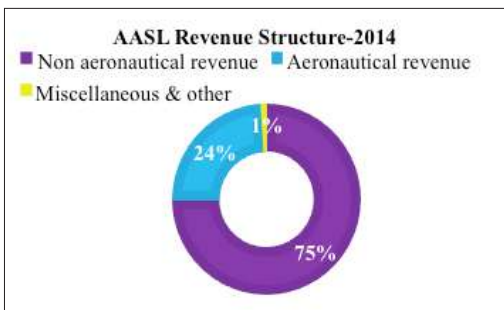


**Figure 3: Annual International Aircraft Movements- BIA (2011-2015)**  
 Source: Statistical Information-AASL

In order to increase the profitability and to boost the productivity it is important to consider about Airport Revenue generation. This is a combination of aeronautical and non-aeronautical revenue sources. Aeronautical income generated due to using of the airfield and terminal area by the airline. AASL (2014) eg: landing and parking charges- domestic and international aircraft, overflying charges and aerobridge charges.

Non-Aeronautical revenue generated due to the passenger dependent activities (ACL, 2007). The non-aeronautical revenue sources of AASL were from “entry permit fees, concessions and other non-aeronautical income etc. (AASL, 2014).

This non-aeronautical category account for approximately four third of the revenue. Though the revenue of AASL account for major 3 Airports (BIA, MRJA, and RMA), major portion of the revenue is contributed BIA.



**Figure 4: AASL Revenue Structure -2014**  
 Source: Annual report AASL -2014

This base of this study is to identify the impact of different movements on total gross revenue of BIA by considering the passenger, aircraft and visitor movements to improve the prevailing situation.

However, it can be seen that there are limited studies to identify the significant impact of different movements on total revenue of an airport as per the difficulty in finding data. This was the motivation behind the present study. Therefore, it emphasizes that the involvement in this kind of study is a significant topic to improve the profitability at BIA.

Though the designed terminal capacity of BIA is 6 million, but in 2015 passenger handling was 8.5 million (CAASL, 2016). It is necessary to consider about future terminal expansions and developments as well as the availability of current facilities and infrastructure to satisfy the demand. Terminal expansions provide an idea about the future of airport business and analyse the factors which didn't focus yet.

The strategic location of Sri Lanka is also an important reason for revenue generation from aviation. Being an island, its connectivity with the other countries is important. Sri Lanka cater as a hub for East Asia, Africa and Middle East. Due to the present trend, most of airlines prefer this air routes across Sri Lanka. In order to facilitate the current situation, it is necessary to focus on the lowest and highest significant traffic movements and identify the means to improve it.

**A. Limitations**

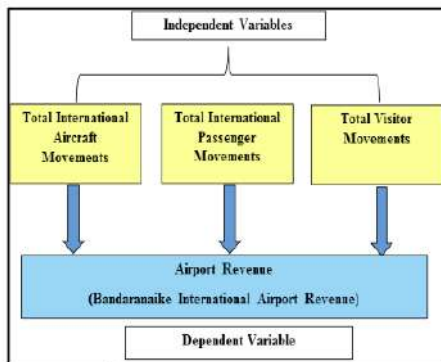
- Monthly revenue figures were collected through Management reports of AASL.
- The data collected constitute with some revenue figures which common for BIA, MRJA, RMA airports. But comparing to BIA, other revenue proportionate are negligible. Due to this reason, the research base is BIA.
- Though there are many categorizations for different traffic movements at an airport, due to the availability of data this considers only the selected movements

**B. Objectives**

- To analyse the impact of total international aircrafts, international passenger and visitor movements on gross revenue of BIA per month.
- To identify the highest and lowest significant movement & provide suggestions to improve the related revenue sources.
- To identify the new avenues of increasing revenue and provide suggestions to restructure the present situation.

**II. METHODOLOGY AND EXPERIMENTAL DESIGN**

The study is emphasizing on both quantitative and qualitative methods.



**Figure 5: Conceptual Framework of the Study**

**Table 1: Summary of variable identification**

Variable	Definition	Unit measure
Total gross revenue of BIA per month	This is the dependent variable in the study	In Rupees ('000)
<ul style="list-style-type: none"> <li>• Total international aircraft movements,</li> <li>• Total international passenger movements,</li> <li>• Total visitor movements per month</li> </ul>	These are the independent variable of the study.	Number of aircrafts  Number of passengers  Number of passengers

Sample include the data of Aircraft, passenger and visitor movements for five years from 2011 to 2015. Simultaneously gross revenue figures were collected accordingly. For each five years, data collected in monthly wise. This represents that the size of the sample is 60.

This research was based on the secondary data collection. The main source of data collection was the Management accounting reports of AASL. Different movements of BIA were collected from Statistical Information of AASL. Other sources include: Annual reports of AASL, Civil Aviation Authority Sri Lanka (CAASL) and Central bank reports. Data collected from the secondary sources were analyzed using the Statistical Package for Social Sciences (SPSS) statistical tool IBM SPSS 20. The results were presented using tables and graphs and following methods were used to analyse the data set.

Hypothesis testing used to test correlation, Model significance and Model coefficient. Descriptive statistics are generally used to describe and summarize the data set.

Pearson correlation coefficient (r) is used to describe the linear association among variables. If the values are closer to -1 it represents a strong negative relationship and if the values closer to +1 it represents a strong positive relationship between variables. This r can take values in between -1 to +1.

This research is based on modelling the relationship between variables with the use of statistical techniques. The analysis of this research is belonged to a multiple linear regression analysis since it has more than one independent variable and objective is to explain and model the relationship among variables in a known population and to predict the values of response variable based on given explanatory variables.

This is dealt with 95% confidence interval. To be significant, P (probability) value < 0.05. The process applied in this scenario is Step- wise. Durbin Watson statistic (DW), Coefficient of determination (r<sup>2</sup>), Residual plots have been used for testing the model validation.

### III. RESULTS

#### A. Descriptive statistics

**Table 3 : Correlation Analysis**

	Total gross revenue	Total International Aircraft movements	Total International Passenger movements	Total visitor movements
N	60	60	60	60
Minimum	649174.0136	3178.00	462367.00	100000.00
Maximum	1536591.4481	4880.00	810736.00	151792.00
Range	887417.4345	1702.00	348369.00	51792.00
Sum	61354731.7897	250538.00	36806878.00	7458593.00
Mean	1022578.8632	4175.6333	613447.9667	124309.8833
SE mean	26758.0441	48.74246	9973.69085	1679.66611
Standard deviation	207266.91839	377.55745	77255.87716	13010.63772
Variance	42959575459.875	142549.626	5968470555.185	169276693.800
Skewness	.235	-.384	.194	.368

This simply summarizes a data set of the sample and statistically describe the key features of data collection.

#### B. Correlation Analysis

Hia: There is no linear association between ith variable and jth variable

Hib: There is a linear association between ith variable and jth variable

(i =Aircraft movements, passenger movements & visitor movements, j=Total gross airport revenue)

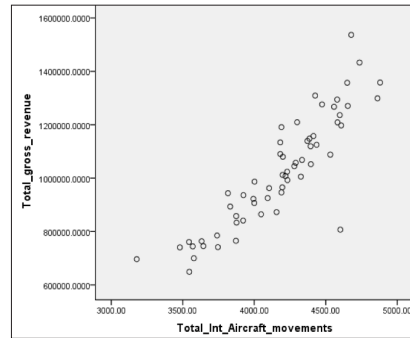
**Table 3 : Correlation Analysis**

		Total gross revenue	Total Int. Aircraft movements	Total Int. Passenger movements	Total Visitor movements
Total gross revenue	Pearson Correlation	1			
	Sig. (2-tailed)				
	N	60			
Total Int. Aircraft movements	Pearson Correlation	.885**	1		
	Sig. (2-tailed)	.000			
	N	60	60		
Total Int. Passenger movements	Pearson Correlation	.873**	.903**	1	
	Sig. (2-tailed)	.000	.000		
	N	60	60	60	
Total Visitor movements	Pearson Correlation	.064	.053	.272*	1
	Sig. (2-tailed)	.626	.685	.036	
	N	60	60	60	60

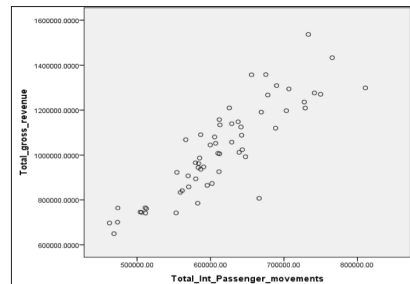
\* - correlation is significant at the 0.05 level (2-tailed)

According to the table 3 it can be seen a linear association between the variables as it is statistically significant (P value < 0.05). Yellow color indicate the significant values.

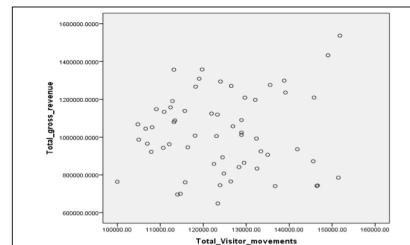
Figure 6 & 7 It can be seen that there is strong positive linear association between the variables. It is statistically significant (P< 0.05). Therefore Hia can be rejected. But in figure 8 there is no linear association between the variables; Hia can be accepted considering related variables.



**Figure 6: Scatter plot between total international aircraft movement vs. total gross revenue**



**Figure 7 : Scatter plot between total international passenger movements vs. total gross revenue**



**Figure 8 : Scatter plot between visitor movements vs. total gross revenue**



C. Model selection

Table 4 : Model Summary

Model	R	R Square	Adjusted R square	Std.Error of the Estimate	Durbin-Watson
1	0.885a	0.783	0.779	97370.2066393	
2	0.901b	0.812	0.806	91321.1708073	1.732

- a. Predictors: (constant), Total\_Int\_Aircraft\_movements
- b. Predictors: (constant), Total\_Int\_Aircraft\_movements, Total\_Int\_Passengermovements

There are two models given by the output. R Square value measures the goodness of fit of the fitted regression. By considering the R2 values of both models, 2nd model was selected.

D. Model development

Following hypothesis were developed in order to carry out a Regression Analysis

- H1a: Intercept is equal to zero
- H1b: Intercept is not equal to zero
- Hia: coefficient value of i th variable equal to zero
- Hib: coefficient value of i th variable not equal to zero

(i = 2,3,4 – Aircraft movements, Passenger movements, Visitor movements respectively)

Table 5 : Coefficients of the variables

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics		
	B	Std. Error	Beta			Tolerance	VIF	
2	(Constant)	-836934.497	143599.126		-5.828	.000		
	Total Int. Aircraft movements	288.164	73.217	.525	3.936	.000	.185	5.406
	Total Int. Passenger movements	1.070	.358	.399	2.990	.004	.185	5.406

Coefficient of variables and intercept are not equal to zero. Hence Hib for Aircraft and passenger movements can be accepted while coefficient of visitor movements equal to zero (Hia can be accepted). Model has excluded the Visitor movement variable.

To further confirm the significant of the model ANOVA Table can be used. The following hypothesis were developed to find the model significance.

- Ha: Model is not significant
- Hb: Model is significant

Table 6 : ANOVA Table

Model	Sum of Squares	df	Mean Square	F	Sig.
2 Regression	2059260246588.370	2	1029630123294.190	123.463	.000
Residual	475354705544.249	57	8339556237.618		
Total	2534614952132.620	59			

It can be concluding that the model 2 is significant with a linear association in a 5% significant level. Hence Ha can be rejected.

E. Regression Equation

The multiple linear regression equation developed by the model is:

$$Y = -836934.497 + 288.164X1 + 1.070 X2$$

Y- Monthly gross revenue of BIA

X1- monthly International Aircraft Movements

X2- monthly international Passenger movements

note that the revenue figures in the data set is in Rs.(‘000)

$$\text{Monthly gross revenue of BIA} = -8362934.497 + 288.164 (\text{monthly international aircraft movements}) + 1.070 (\text{monthly international passenger movements})$$

F.Model validation

- 1) R square value: According to the table 4 above R square of the model is 0.812. This implies that 81.2% variation of dependent variable is explained by the independent variables (total monthly international aircraft and passenger movements).
- 2) Durbin Watson Statistic: According to the table 4 above, Durbin Watson (DW) value is 1.732. This value is approximately closer to 2. It confirms that the errors are normally distributed.
- 3) Cook’s Distance: In this scenario it represent a maximum of 0.335, mean of 0.020. These figures are not influential.

4) Variance Inflation Factor: The presence of multicollinearity in a model is analyzed with the use of Variance Inflation Factor (VIF). According to the table 5 VIF value of the model 2 is 5.406. If the value is between 1-10 there is no multicollinearity.

5) Residual plots: Figure 9 depicts that residuals are normally distributed as Histogram represents a “Bell shape”

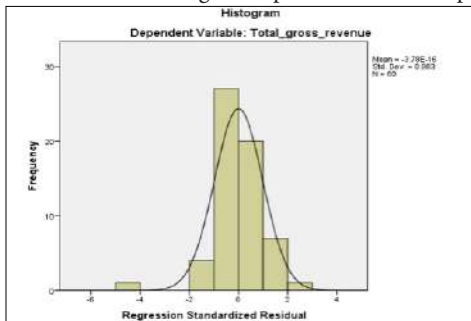


Figure 9 : Histogram of Residuals

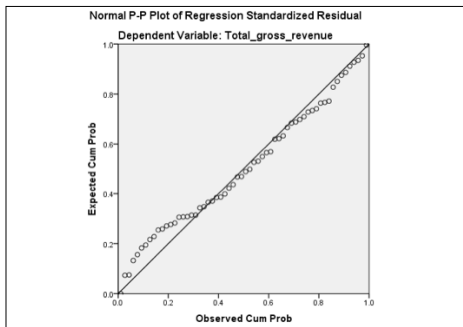


Figure 10 : Normal P-P Plot of Regression Standardized Residual

The figure 10 illustrates that the residuals are lie near to the straight line. It can be confirming that the errors are normally distributed & also Scatter plot conclude that there is no definite relationship between residuals and predicted values hence a random pattern around zero standard residual line.

## IV. DISCUSSION AND CONCLUSION

Monthly gross revenue of BIA significantly depends on International aircraft and passenger movements (according to the variables considered in this model).

- The R square of the model is 0.812
- R between revenue and Aircraft Movements is 0.885
- R between revenue and Passenger movements is  $r = 0.873$
- Highest impact is from international aircraft movements
- Lowest impact is from monthly visitor movements.

But when revenue increases, cost increases.

It is important to maximize the revenue through maximum utilization of current infrastructure and then think of building new infrastructure such as second runway.

### A. Suggestions to improve the aircraft movements and related avenues of revenue

- Runway capacity should increase.
- Facilitate fast turnaround time for an aircraft.
- Separate terminals for Domestic and low cost operators.
- Allowing Fixed Base Operators (FBOs) operate the airport.

### B. Suggestions to improve the passenger movements and related avenues of revenue

- Minimize current difficulties face by passengers.
- Increase the duty-free shops in arrival area.
- Increase number of baggage belts.
- Improve recreational facilities.
- Creating an environmental friendly mind relaxing environment.

### C. Suggestions to improve the visitor movements and related avenues of revenue

- Opening of public viewing gallery for visitors.
- Expand the waiting lobby area for visitors.
- Closer proximity vehicle parking area for visitors.

## ACKNOWLEDGMENT

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# STUDY ON JOB SATISFACTION AND ABSENTEEISM AMONG SENIOR & JUNIOR SAILORS OF MEDICAL BRANCH IN SRI LANKA NAVY

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**Abstract** - Physical and Mental Health of Naval personnel is essential for an efficient Navy. All naval commands have a naval hospital that look after health needs of the respective command. The medical staff of these hospitals consist of consultants, medical officers, psychologists, counselors, Admin Officers of Health, Nursing Officers, Para Medics, and Medical Assistants. However, it has been noted come to notice that absenteeism rate has increased in the medical branch progressively during the last 3 years. Due to the negative effects of this, it was understood the importance of exploring possible reasons that affect absenteeism and job satisfaction. Thus, the research aimed to explore reasons for absenteeism, factors that affect job satisfaction, recommendations to reduce turnover rate and to increase job satisfaction in medical branch. A semi structured questionnaire comprising of Likert scale questions, open ended questions, and close ended questions was used to collect data. 347 medical assistants representing both male and female of all rates participated. 68% of medical assistants strongly agreed that “giving proper duty shifts” as a good way to reduce absenteeism rate. 64% have strongly agreed with the idea of “minimizing non-medical duties as much as possible” as a way to reduce the turnover rate. 60% of participants strongly agreed that giving duties matches with their professional training and it would increase job satisfaction. 76% of the participants agreed or strongly agreed that Job is secured as long as they do

their job well. 73% of the participants strongly agreed or agreed that their job helps them to learn lots of skills. 73% of the participants strongly agreed or agreed that this their job helps to improve experiences. The research findings constructively contributed to make important recommendations to reduce absenteeism and increase job satisfaction.

**Key Words** - Job Satisfaction, Absenteeism, Health

## I. INTRODUCTION

Physical and Mental Health of Naval personnel is essential for an efficient Navy. All naval commands have a naval hospital that look after health needs of the respective command. Naval personnel, civilians who work at navy and family members of naval personnel are treated at these hospitals. Majority of naval patients are being managed in the Navy Hospitals and Sick Quarters.

The medical staff is consisted of consultants, medical officers, nurses, psychologists, counsellors, Admin Officers of Health, Para medics, and medical assistants. Majority of medical assistants have gained specialized training in many disciplines both in Sri Lanka and abroad.

It has come to apprehension that though the absenteeism rate is comparatively low, it has been progressively increased during last 3 years. 16 medical assistants representing all rates have left the Navy 2014. 18 medical staff and left in 2015, 29 in 2016. According to above statistics, It is clear that the absenteeism rate has been increased from 2014-2016.

Increase of absenteeism rate affect the Navy and medical branch in many different ways. When trained staff leaves the navy unexpectedly, staff shortage affects the proper functioning of the naval hospitals. When the number of medical staff reduces, it affects those who are currently working as it creates extra pressure to them as they have to cover the shortage. As a result, it increases the workload of the present medical staff. Then this extra pressure could also affect the present staff to leave the navy. When a trained person leaves the navy, it economically cost to the navy. It cost a lot more to recruit new person and train. Hence, it also economically affects the navy. The most important element of any organization, manpower is satisfied with their jobs (Habibi 2015). According to a study conducted on Job satisfaction among nurses' staff in military health care of Northern Greece, results of the regression analysis when performing Pearson correlation coefficients (correlation significance at the level 0, 05 two-tailed) showed that the decrease in job satisfaction was predicted by week-end work  $p= 0,020$ ,  $r= -0,222$  by night shift  $p= 0,005$ ,  $r= -0,266$  (Malliarou, Malliarou and Konstantinidis 63-71) However, due to the negative effects from absenteeism in medical branch, it was understood the importance of exploring possible reasons that affect absenteeism and job satisfaction of medical branch health care professionals in Sri Lanka Navy.

Absenteeism & job satisfaction appears to have a close connection. Spector (1997) defines job satisfaction simply as "the degree to which people like their jobs and the different aspects of their jobs." Robbins (1998) defines job satisfaction as a general attitude towards one's job; the difference between the amount workers receive and the amount they believe they should receive. In the current research, researchers aimed to explore factors that affect job satisfaction and reasons for absenteeism as well.

## II. OBJECTIVES OF THE STUDY

- a) To explore reasons for absenteeism.
- b) To explore factors affect job satisfaction.
- c) To make recommendations to reduce turnover rate.
- d) To explore how to increase job satisfaction in medical branch.

## III. METHOD

### A. Data Collection Method and Tools

A questionnaire was used to collect data that participants could self rate. The questionnaire comprised of Likert scale questions, open ended questions, and close ended questions. Both qualitative and quantitative methods were involved as there were open ended questions that could be analysed qualitatively.

### B. Sample

This questionnaire was distributed among 347 medical assistants representing all naval commands. Both male and female medical assistants from all rates were participated.

Following table shows the number of participants from different commands.

	Command	Number of Participants
1	Western command	188
2	Southern Command	29
3	Northern Command	32
4	Eastern Command	58
5	South East Command	10
6	North West Command	30
7	North Central Command	30

### C. Procedure

The questionnaire was developed by an expert panel comprised of a Consultant Psychiatrist, Senior Medical Officer and 2 counselling officers. Questions were prepared based on already identified factors that affect turnover. The questionnaire had 4 main sectors. Demographic section, Reasons for absenteeism, Ways to reduce absenteeism and section that measure Job satisfaction.

The questionnaire was distributed among 347 participants representing all commands according to the samples stated in the above table.

### D. Data analysis method

The data was analysed qualitatively and quantitatively. Averages and percentages were calculated using basic statistic methods. Thematic analysis method was used to analyse qualitative data.

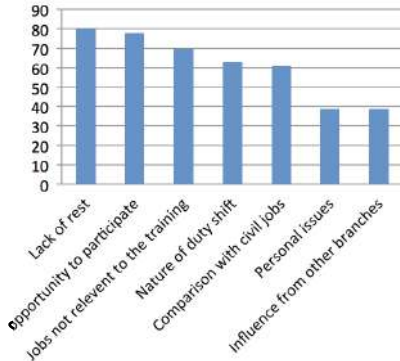
**E. Ethical considerations**

1) Anonymity and confidentiality: Identifiable information like name, official number and other personal information that could indirectly help to identify the participants were deliberately avoided. Participants were assured that all information they share would be treated with the utmost confidentiality and that their anonymity would be respected at all times unless otherwise determined by law. They were educated that their answers would not affect their job directly or indirectly and only used collectively for research purpose.

**IV. ANALYSIS AND RESULT**

**A. Reasons for absenteeism**

Participants were asked to select reasons that could be consider whether they affect for the absenteeism of medical staff. They were asked to choose correct or wrong and below graph summarizes the percentages for reasons that affect increased absenteeism rate:



**Graph 1: Reasons for absenteeism**

According to the above graph,

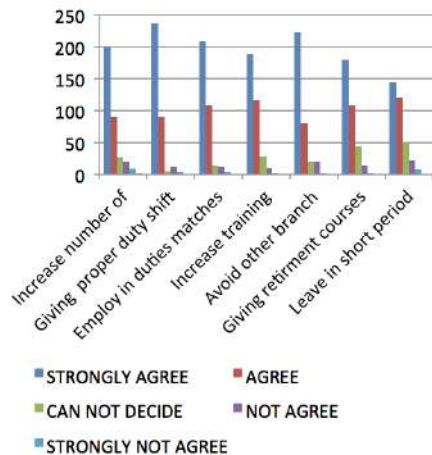
- 80% of participants has stated that Lack of rest as a reason for increased turnover rate.
- 78% of the sample has stated that not being able to participate family and children’s special occasions as a reason for absenteeism.
- 70% stated that “Not receiving job tasks that are relevant to training” as a factor that affect absenteeism.

- Nature of the duty shifts has been selected by 63% of participants as a reason for absenteeism.
- Comparing the naval medical job with medical jobs at civil settings is mentioned by 61% of participants as a factor that affect the absenteeism.
- 40% has stated that influence from other branches is also a reason for absenteeism rate.
- 40% stated that personal issues affect absenteeism.

**A. Ways to reduce absenteeism**

Participants were asked to specify their level of agreement to statements presented in the graph below and result is shown below.

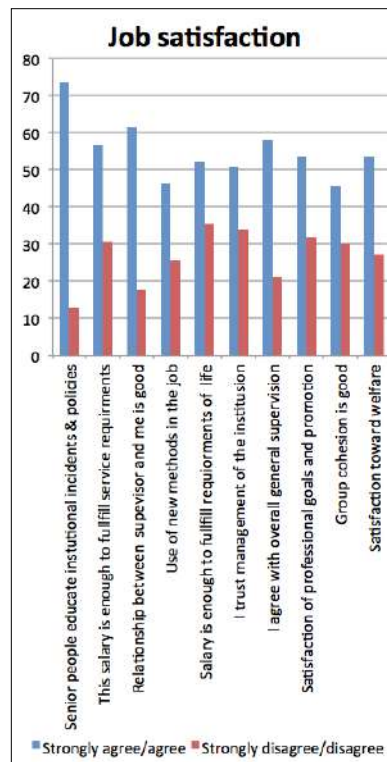
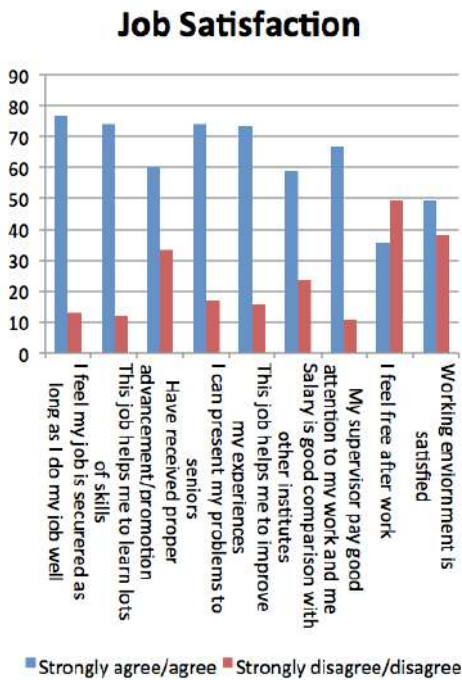
**Ways to reduce turnover**



**Graph 2: Ways to reduce absenteeism**

According to the graph above, 237 participants (68%) strongly agreed that “giving proper duty shifts and rest” as a way to reduce absenteeism rate in medical branch. 223 participants (64%) have strongly agree to statement of “Avoiding unnecessary other branch duties” as an another way to reduce the absenteeism rate. 60% of the participants strongly agree that giving duties matches with their professional training.

**B. Job satisfaction**



**Graph 4: Job Satisfaction Scale**

According to the above graph that summarizes the level of agreement to different factors related to Job Satisfaction of Medical Assistants, 102 out of 347 medical assistants 29% “Strongly Agrees” with the statement that “I feel my job is secured as long as I do my job well” and 164 out of 347 (47%) “Agree” with the above statement. 76% of the participants Agree or strongly agree with the fact that Job is secured as long as they do their job well. According to the above statistic, “Job Security” is the fact highest percentage of medical assistants has agreed related to job satisfaction. 73% of the participants ‘strongly agree’ or ‘agree’ that “this job helps to improve skills and knowledge”. 73% of the participants “Strongly Agree” or “Agree” that this job helps to improve experiences

Below graph shows other important components of job satisfaction that highest percentage of medical assistants have “agreed” or “strongly agreed”

73% of the participants “Strongly Agree” or “Agree” that senior people in this institute educate them about intuitional incidents and polidies. 58% strongly agree that salary is enough to fulfill service requirements. 52% agree that salary is enough to fulfill requirements of life. 60% agree with the overall managements and 75% agree that senior people of this organization educate them about intuitional policies and incidents. 75% says that they can present their issues to seniors which are a good factor for Job satisfaction. 72% strongly agree that this job helps them to improve their professional skills. 62% agree that “relationship between seniors is satisfied.

**A. Qualitative data analysis**

Participants were asked to write reasons that they think would that affect the turnover in the medical branch by posing an open ended question. 93 participants have responded to this open ended question. The responses from 93 participants to above question were recorded and analysed using thematic analysis method. Result is presented according to themes below.

- 1) Insufficient staff; when there is a staff shortage, it affect other staff and it is mentioned that it creates stress among medical assistants
- 2) No off time after night duty; Not receiving the “off time” they are entitled after doing 24 hour duty has been mentioned as a major reason for job distress.
- 3) Doing non medical duties; 16 participants out of 93 have mentioned that having to do non-medical duties in the base affect the turnover rate in the medical branch. Further, they have mentioned that they sometime have to do other work even when they have medical branch commitments to fulfill. Especially they have mentioned that in detachments, they are frequently appointed for other branches’ non medical duties and they mention that it affect their medical duties and responsibilities.
- 4) Mental distress; A major theme appeared in the data related to mental distress among medical assistant as a reason for higher absenteeism rate. Further, they described that there is no mental relief due to the nature of medical duties and responsibilities. They further reported that not getting a proper off time after night duties increases the mental distress cause due to the nature of medical duties.

## V. CONCLUSION

According to research findings presented, reasons for absenteeism are not receiving entitled off time after 24 hours duty shift appears to be a major factor. Lack of rest, mental and physical distress, also has a connection to not receiving off time after 24 hour duty shift. Further, participants have mentioned that they have to engage non medical duties and it affect their primary role as a medical professional. Participants recommend that if there is a way to reduce non medical duties as much as possible would be helpful to increase efficiency and motivation. When we look at this issue though employer’s perspective, they have to make employees engaged in their off time due to lack of staff. Hence. The main reason for this issue appears to be “lack of staff”. Lack of sufficient staff affects absenteeism and it increase the rate of absenteeism more and it work as a cycle and affect one another. Hence, it can be recommended that having a sufficient number of staff may reduce the absenteeism rate. When there is an issue of “lack of staff”, engaging non medical duties affect it further.

Regarding motivational factors, “job security” was presented as a major factor for motivation. Being able to present issues to seniors was also appeared as a positive factor. Further, being able to improve professional skills, senior people educating them about institutional policies were identified as a motivational factor for the job. According to these findings, it appears that though there were factors that affect absenteeism, there are factors that affect job satisfaction. It can be recommended that educating employees those who are not aware of these motivational factors that they can be satisfied on the job as a way to reduce absenteeism. Also, there should be proper solutions for factors that directly affect absenteeism such as increasing the number of medical staff and then by increasing the staff, they can be given the ‘night off” so that they can have the rest time they deserve after 24 hour duty.

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# COST OPTIMIZATION OF DISTRIBUTION NETWORK IN COCA COLA BEVERAGES SRI LANKA LIMITED

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**Abstract** - This research investigates cost mitigation in outbound distribution system of the beverage industry. The increasing cost of fuel and maintenance of trucks drives the requirement of cost optimization in outbound logistics. As a beverage manufacturing company, Coca Cola Beverages Sri Lanka has to be competitive by reducing its cost of distribution while maintaining the service level. For the purpose of reduction of the distribution cost, an analysis is carried out using secondary data that is obtained from Sales Reports and SAP system of the company. High demand fluctuations have been observed which directly influences the cost of distribution. Although the company has sought to optimize their distribution operation, the basis of truck allocation is not rational because the company focuses to deliver shipment, based only on distributor order without taking into consideration the average demand of a particular region. Thereby high number of small trucks travel to the distributors in a same region instead of consolidated shipments in a high capacity truck. So evaluating this scenario, a decision has been taken to create a systematic approach for truck allocation by cost comparison of different capacity trucks depending on the mileage. Hence to optimize the cost of outbound distribution, a mathematical model was developed by using Integer Linear Programming using reliable sources to collect data. Software assistance is taken by Lingo 13 optimizer tool to solve this mathematical model. In addition to the optimized mathematical model, the importance of using such a system in the distribution network is stressed by presenting a cost reduction of approximately 18% compared to current scenario.

**Key words** - Optimization, Distribution, Operations

## I. INTRODUCTION

Coca Cola Beverage Sri Lanka Ltd (CCBSL) vision statement is, "To be the leading beverage Company in Sri Lanka with sustainable, profitable volume growth by being consumer driven and consumer focused grounded in living the SABCO values and being a respected corporate citizen". (Annual report of CCBSL 2011)

With reference to the above statement, profitable volume growth can't be maintained without having a reliable, efficient and streamlined supply chain. Instead of operating few warehouses Coca cola company has centralized these operations and warehouse in Biyagama which has reduced the capital cost and operation cost significantly. Hyper competitiveness in the business world drives a company's supply chain to be profitable while offering competitive price for their product. To obtain such a position organizations have to implement innovative logistics strategies.

Coca Cola beverages Sri Lanka's distribution can be distinguished by two main components such as collection and delivery. Collection method is defined when distributor-owned vehicles arrive to collect their shipment from Coca cola plant. The transport cost of collecting the shipment is borne by the company, because a net sale rate (piece rate for cases) or haulage (Non- NSR) is paid to the distributor. Delivery method is defined when company arranges the delivery to the distributors' warehouse. Major portion of shipments are distributed under delivery method because general trade and direct sales distribution because it includes cinemas, leisure, super markets etc.

Blend of rented and hired trucks are used for the outbound logistics. However cost contribution is considerably high in this distribution operation, because company allocates these trucks in an ad-hoc method. When demand increases the company hires contracted transporters on a short term basis to which the company has to pay a higher rate on the other hand when the demand falls, part of the vehicle fleet idles due to lack of orders. Therefore there is a need for cost optimization of the distribution system while retaining the service level. As a make-to-stock manufacturer, finish products should be pushed to the closest point of customer. This is difficult as many small-scale distributors purchase small volumes because of the lack of storage capacity, customer demand variability and probability of expiry of products before selling. Distributors usually order small volumes (LTL) at a frequent interval therefore company has to allocate small trucks while large trucks idle for which rent should be paid even though the vehicles are not utilized. At the same time loading and unloading operation is queuing unnecessarily, on other hand resource overutilization and overtime operation upsurges operation cost.

## II. METHODOLOGY

Different methods are used to recognize the appropriate system that can optimize cost of distribution while maintaining same service level of Coca Cola Beverages Sri Lanka. The system can be identified by answering research objectives sequentially using gathered data of sales volumes and truck operation cost in order to determine the variables and constraints to create a mathematical model for this research.

The research is based on quantitative aspect of methodology to identify a cost optimized model. To facilitate this model quantitative data is vital, therefore sales information and truck rates of Coca Cola Beverages Sri Lanka is used to make this tailor-made cost optimization model.

In order to achieve research objectives, the research based on mathematical technique rather than statistical technique. Therefore secondary data is used for the analysis to create optimization model. To obtain average demand of every individual distributor, data from SAP system of Coca Cola Beverages Sri Lanka is used. As an Enterprise Resource Planning system SAP provides effectiveness to logistics practices by delivering reliable and updated information.

By minimizing the hiring cost, the distribution cost can be minimized hence optimizing the overall logistics cost. To minimize the cost, this research will use linear programming model which one of the methods commonly used to optimize a problem. In real world situation, linear programming is successfully used to determine optimal solution because proved useful in modeling diverse types of problems in planning, routing, scheduling, assignment, and design. (Wikipedia. 2013) Mixed integer linear programming can also be used to calculate effective way of distribution.

Population of this research is 130 individual distributors who are located in island wide. As a sample the top 25 distributors in 5 regions were selected who hold the highest demand volume (which represent 40% of the total cost of transport) respect to their mode of distribution that is by means of “delivery method” not “collection method”. Of these five regions the total demand volume is considered from 25 distributors. The 25 distributors are selected based on the distributors of each region whose monthly demand volume is greater than 1500. The demand is collected for a period of one year, because in the FMCG industry a period of one year will include the seasonality factor. Therefore sample represent 19% of the population.

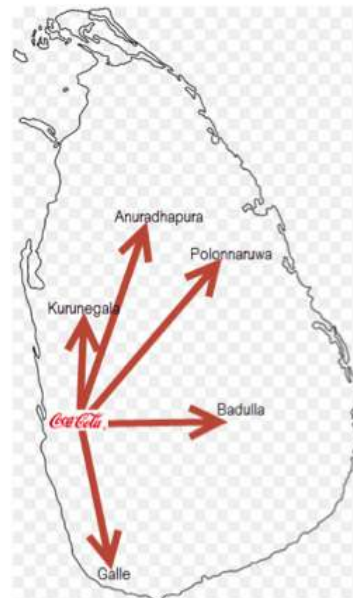


Figure 1 : Sample Regions

**Objective function:**

$$\text{Minimize } z = \sum_{i=1}^m \sum_{j=1}^n C_{i,j} U_{i,j}$$

Where:

- Z = total cost of renting a truck for each area
- I,,m = the transporters
- J,,n, = truck type
- C<sub>i,j</sub> = Truck rental costs per unit of the transporter truck i with type j
- U<sub>i,j</sub> = The number of trucks that use of the transporter i with truck type j

Subject to.

$$\sum_{i=1}^m \sum_{j=1}^n U_{i,j} \geq d_{vol}$$

$$\sum_{i=1}^m \sum_{j=1}^n U_{i,j} \geq d_{ton}$$

$$\sum_{i=1}^m \sum_{j=1}^n U_{i,j} \geq t_{i,j}$$

- U<sub>i,j</sub>)= Integer value
- U<sub>i,j</sub>)≥0 For all i and j

Where:

- V<sub>i,j</sub> = The maximum volume per truck of transporter i with trucks type j
- U<sub>i,j</sub> =Numbers of truck used by transporter with truck type
- b<sub>i,j</sub> =Maximum weight (payload) per truck of transporter with truck type
- dvol = Request for delivery of goods in unit volume in cubic
- dton =Request for delivery of goods in units of tonnage (weight)
- t<sub>i,j</sub> =The maximum number of trucks that can be used of the transporter i with truck type j

All the three alternatives evaluated the allocated number of specific type of truck are similar thereby deriving that these figures amount to the minimum number allocated to each area. In comparison to the actual number of trucks utilized in the operation the numbers derived from the above computations is actually less. When the average costs of the three alternatives are compared obtained the following result alternative three shows the highest cost

saving or the minimum cost while the alternative two shows a moderate cost saving while alternative 1 showed the lowest cost saving. These average cost differences have been obtained since various transporters have been utilized in the operation which charge different freight costs. This model suggests that the relevant company is required to reevaluate their route planning to make it effective and efficient in order to gain maximum profitability through reduction in overall distribution costs because an optimal solution does exist.

**Model development**

In order to develop a mathematical model for optimized cost of distribution by allocating trucks in a cost effective manner an equation is built based on the model proposed by (Djamaris et al 2012) . The original equation has four variables in determining the minimum cost but this equation is formulated using only three variables because at CCBSL a common rate is paid for all transporters irrespective of their type of contract with the company.

$$\text{minimize } Z = \sum_{i=1}^{12} \sum_{j=1}^4 \sum_{k=1}^3 C_{i,j,k} * X_j \quad (1)$$

$$C_{i,j,k} = i^{th} \text{Rate} \times j^{th} \text{Truck type} \times k^{th} \text{Distance} \quad (2)$$

Where:

- Z = Total cost of rented trucks
- i = Per case per kilometer rate
- j = Truck type
- k = Distance class interval that the particular region falls into
- C<sub>i,j,k</sub> = Cost per trip
- X<sub>j</sub> = number of trucks in truck type j

**Constraints:  
Demand for a region,**

$$\sum_{j=1}^4 V_j \times X_j \geq D_r$$

Where:

- V<sub>j</sub> = Volume of truck type j
- X<sub>j</sub> = Number of trucks type j
- r = region(r=1,2,3,4,5)
- D<sub>r</sub> = Demand for region r

Truck availability,

$$\sum_{j=1}^4 X_j \leq T_j$$

$X_j$  = integer value  
 $X_j \geq 0$

$T_j$  = Number of truck available in truck type j  
 $X_j$  = Number of truck in truck type j, going to the respective region.

**The research Techniques**

Solving optimization model is comprehensive task that includes a lot of time required for calculation. But these models have economic value when considering the supply chain optimization. As a result of that lot of logistics solution providers emerge to cater the uprising demand and these custom made solutions are highly paid by companies. At the same time software is also developed to facilitate these mathematical models for accurate calculations. By coding objective function and all the constraint in particular programming language, solution can obtained faster and without errors in the calculations. Lingo is one of popular software tool among industry professionals in transportation, logistics and finance for reliable modeling calculations.

Lingo software facilitates optimization modeling in linear, nonlinear, quadratically constrained, second order cone, stochastic and integer models in an easier and faster way. It contains integrated package that provides powerful programming language for expressing optimization modeling and fully functional software for building and editing problems.

Model development time is significantly reduced using this software. This software allows user to formulate linear, nonlinear and integer problems with minimum deviation from usual writing language. Thereby models are easy to understand and maintain. This has become user friendly by introducing system to allow user to manage data directly in spreadsheets and databases. And in the same way, result can be generated in spreadsheets according to the user's choice.

Lingo is comprehensive tool that can identify Linear, Nonlinear, Stochastic, Integer optimization and etc. It reads

formulation and automatically selects the appropriate one. Because of that there is no need to specify or separate solver. Lingo User Manual describes all commands and features in understandable language. Thereby this software selection is justified as an effective tool for this research model.

**Descriptive Analysis**

According to the data collected from monthly sales report of Coca Cola Beverages Sri Lanka, sales volume of 25 individual distributors is extracted. It shows the volume fluctuations during a period of one year. Seasonal factors, such as weather, cultural events, social events etc. heavily impact on demand of the monthly sales volumes. Though the demand varies company should have to allocate their fleet to fulfill the requirement as the service level is critical to sustain the market share. When they focus on market share they lose the interest on optimizing the fleet. Table 2 shows summary of monthly demand.

**Table 1: Average demand for regions**

Area	Distributor	Average volume monthly	Weekly average volume	Total average weekly volume for the region
Kurunegala	K-1	9,244	2311	5,997
	K-2	8,700	2175	
	K-3	3,980	995	
	K-4	2,065	516	
Galle	G-1	4,449	1112	6,819
	G-2	2,970	743	
	G-3	2,016	504	
	G-4	14,767	3692	
	G-5	3,073	768	
Badulla	B-1	3,281	820	3,533
	B-2	3,227	807	
	B-3	2,794	699	
	B-4	1,875	469	
	B-5	2,954	739	
Anuradhapura	A-1	3,284	821	4,916
	A-2	3,637	909	
	A-3	4,130	1032	
	A-4	2,442	610	
	A-5	3,763	941	
	A-6	2,407	602	
Polonnaruwa	P-1	2,996	749	2,808
	P-2	2,592	648	
	P-3	1,947	487	
	P-4	1,900	475	
	P-5	1,797	449	

According to table 1, distributors are clustered into regions based on their geographical location. Considering monthly demand during a year and weekly demand have been computed. Thereafter optimizing delivery considers region as one location because the relative distance between each distributor in same region is negligible when compared to the distance from plant to the region.

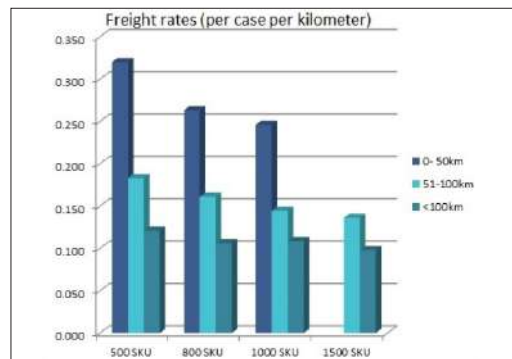
Major portion of transport providers are contracted on hire basis. The freight rate that is paid to the transport by Coca Cola Beverages Sri Lanka influenced on number of factors, such as; travel distance, number of cases carried etc. The freight rate for particular distance group depends on the truck type. Table 2 shows example for 1000 SKU truck type. For detailed information of all truck types refer appendix B.

**Table 2: freight rates for 1000 SKU trucks**

	50KM	51-100KM	>100KM
<b>Rate</b>	0.246	0.144	0.109
<b>No. of cases</b>	1000	1000	1000
<b>Distance</b>	-	-	300
<b>Payment</b>	12,306	14,443	32,608

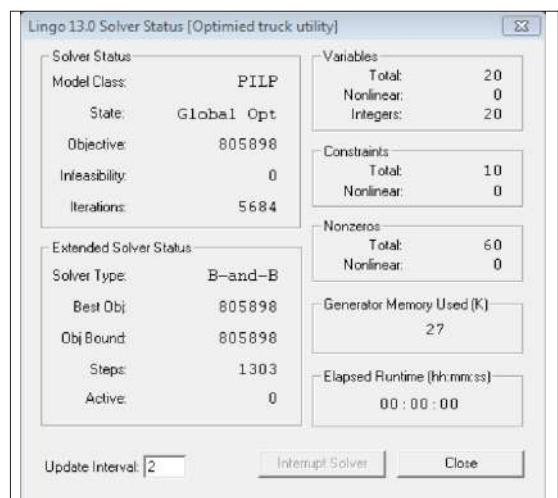
payment=rate \*number of cases\*distance

Table 2 depicts how the calculations of payments are influenced by the following mentioned factors. Mileage factor is categorized into three groups, that is 50km, 51-100km,>100km. Rates row shows three decimal figures that contain the influence of many factors such as fuel component, labour component and wear & tear component and with a certain profit percentage that the company expects to give to the transporter. Therefore by getting summation of all the components, minimum payment that will be given to each transporter has been defined. As there are two price components which are minimum payment and the general payment, only general payment value that has the greater value is considered as the freight rate per case per kilometer. The freight rate is calculated by taking the market price into consideration. When the freight rates have been calculated, value of per case per kilometer changed inversely comparable to the distance. But payment has not been twice even distance gets double. Hence utilization can be maximized by using trucks to deliver orders in more than one location. As illustrated in chart 1, 1000 SKU truck payment for 50 km is 12,306 /= and for 100 km 14,443 /=. Even if the particular truck travels 300 km the charge is 32,608 /=.



**Chart 1: Freight rates**

Chart 1 shows the freight rate per case per kilometer of high capacity trucks are lower than low capacity trucks when it used for long distance. This graph shows the economies of the scale in transportation. These details provide how to allocate trucks and which truck type should be given priority which is the high capacity trucks rather than low capacity trucks. Advanced fleet planning is carried out, by getting the forecasted demand and thereby calling only the required type of truck based on capacity which will positively effect on cost optimization in distribution network of CCBSL.



**Figure 2 Status window**

**Global optimal solution found.**

Objective value : 805898.0  
 Objective bound : 805898.0  
 Infeasibilities : 0.000000  
 Extended solver steps : 1303  
 Total solver iterations : 5684

Model Class : PILP

Total variables : 20  
 Nonlinear variables : 0  
 Integer variables : 20

Total constraints : 10  
 Nonlinear constraints : 0

Total nonzeros : 60  
 Nonlinear nonzeros : 0

Row	Slack or Surplus	Dual Price
1	805898.0	-1.000000
C1	103.0000	0.000000
C2	192.0000	0.000000
C3	67.00000	0.000000
C4	181.0000	0.000000
C5	84.00000	0.000000
C6	0.000000	0.000000
C7	0.000000	0.000000
C8	0.000000	0.000000
C9	0.000000	0.000000

**Figure 3 : Lingo solution**

Variable	Value	Reduced Cost
X_1K	3.000000	11858.00
X_2K	2.000000	16621.00
X_3K	3.000000	21364.00
X_4K	0.000000	28812.00
X_1P	0.000000	26620.00
X_2P	0.000000	37312.00
X_3P	0.000000	47960.00
X_4P	2.000000	64680.00
X_1B	1.000000	27225.00
X_2B	2.000000	38160.00
X_3B	0.000000	49050.00
X_4B	1.000000	66150.00
X_1G	1.000000	13310.00
X_2G	0.000000	18656.00
X_3G	2.000000	23980.00
X_4G	3.000000	32340.00
X_1A	1.000000	26015.00
X_2A	0.000000	36464.00
X_3A	0.000000	46870.00
X_4A	3.000000	63210.00

Descriptive answer gives the optimal cost that can be reached under the given constraints and optimal value that takes for variables. The value is given by the number of trucks that are allocated for particular region, under different truck types.

Solution report of Lingo, delivers figures call reduced cost of each and every variable. That figures can be interpreted as to how much that objective coefficient in the variable can improved before it would become profitable. And the column of slack or surplus, provide satisfaction level of constraint considering as equality. If the constraints are less than or equal to (< or =), it become Slack. And greater than or equal to (> or =) defined as a surplus. When to exact satisfaction of slack or surplus have been occurred the value becomes zero. At the same time constraints which are violated, given the negative value by deriving infeasibility of the solutions. Hence, solution given by Lingo13 for the optimization model becomes feasible.

Table 2 shows the cost comparison of truck allocation in Coca Cola Beverages Sri Lanka. For detailed information refer appendix A. Currently prevalent method is to allocate truck as per the distributors request. If it is an order for which an appropriate truck is not available, the shipment will delay until the truck with the required capacity is available.

Hence, distributors used to place the order when their stock are about to be out of stock. This set-up is root cause for facing many difficulties when the demand suddenly fluctuates. Truck utilization can be improved by delivering goods to the region which include cluster of distributors. Otherwise truck requirement increases while truck utilization decreases. At the same time company can use 1500SKU trucks for delivering consolidated shipments without limiting to long distance single shipments (FTL). If the proposed cost optimized model is used instead of ad-hoc method, company can minimize the distribution cost 979,819 LKR to 805,898 LKR as calculated in table 4. This difference is illustrated in chart 2 which account to 18% cost reduction shown in table 5. If this 18% cost reduction figure is computed for the entire year the reduction in cost exceed 1million rupees in saving to the company.

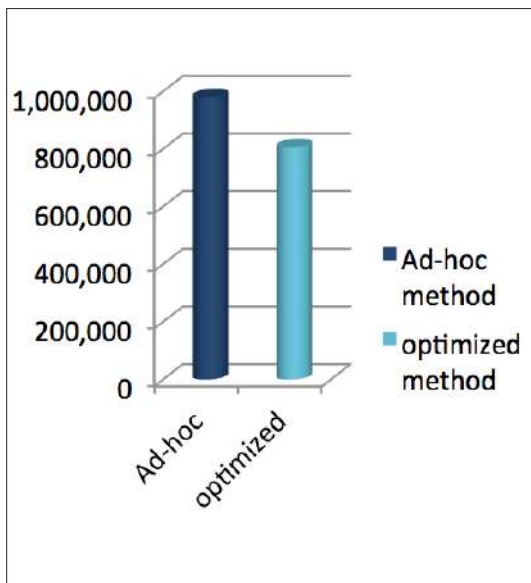


Chart 2 : Distribution cost

Table 2: freight rates for 1000 SKU trucks

Area	Distributor	Weekly average volume	Distance	cost
Kurunegala	K-1	2311	196	56,938
	K-2	2175	196	49,843
	K-3	995	196	23,716
	K-4	516	196	11,858
Galle	G-1	1112	220	37,312
	G-2	743	220	18,656
	G-3	504	220	13,310
	G-4	3692	220	98,516
	G-5	768	220	18,656
Badulla	B-1	820	450	54,450
	B-2	807	450	49,050
	B-3	699	450	38,160
	B-4	535	450	38,160
	B-5	739	450	38,160
Anuradhapura	A-1	821	430	52,030
	A-2	909	430	46,870
	A-3	1032	430	52,030
	A-4	610	430	36,464
	A-5	941	430	52,030
	A-6	602	430	36,464
Polonnaruwa	P-1	749	440	47,960
	P-2	648	440	37,312
	P-3	487	440	26,620
	P-4	475	440	26,620
	P-5	449	440	26,620
<b>total cost</b>				987,805
<b>optimized cost</b>				805,898
<b>cost saving</b>				181,907

## Conclusions

After analyzing the collected secondary data that is gathered from SAP system of CCBSL, a high demand fluctuation is derived over the given period of time. When the company plans to retain the same service level, demand fluctuations cause to increase haulage cost drastically because distributors prefer to order small quantities (LTL) when they have risk of low demand. As a solution, the company hires small trucks instead of going for a cost effective methodology. With the strategic decision that is taken in the recent past to transform to the cartelized distribution, company has obtained route optimization. Although the routes are optimized the deliveries are planned based on order without considering haulage cost which is not cost effective.

Analysis carried out in this research provides cost comparison of different capacity trucks depending on the mileage. The model has been developed using integer linear programming considering several factors and the demand of the regions. When the model is fed with the number of available trucks of different capacities, most cost effective allocation is computed with overall cost. As a result of that, truck utilization is increased and truck requirement reduces compared to ad-hoc method which is currently prevalent at CCBSL. This model gives more weight to high capacity trucks through long distances which are cost effective than low capacity trucks. The model also facilitates to reduce the backlog of orders by coupling loads in same region in advance. With the streamlining of number of trucks that used for deliveries, the cost of distribution has been drastically reduced.

Through the developed model and which is run through the Lingo optimizer tool, the results obtained can be used to plan weekly distribution operation without idling trucks.

Therefore in conclusion using this model, Coca Cola Beverages Sri Lanka has achieved 18% cost saving per week than ad-hoc method that currently used in the distribution system. The reduced cost percentage of 18% amounts to LKR 173921 per week which results in an annual saving of approximately nine million LKR to the company.

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# DETERMINANTS OF CORPORATE SUSTAINABILITY REPORTING: EMPIRICAL EVIDENCE FROM SRI LANKAN LISTED COMPANIES

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**Abstract** - The aim of the study is to identify the determining factors of firm-specific and board-specific characteristics on the sustainability reporting of Sri Lankan listed companies. The sample consists of 220 companies listed in the Colombo Stock Exchange for the period of 2012-2016. The secondary data were collected while logistic regression analysis was executed to test the hypotheses. Logistic regression results suggest that profitability, firm size, leverage, firm growth and firm age are significant firm-specific determinants of corporate sustainability disclosure while board size, board independence, female directorship and board ethnicity are significant board-specific characteristics of sustainability disclosure of firms in the sample. Both firm age and boards with female directors are negatively associated with sustainability disclosure, whereas all other significant variables are positively associated. Moreover, the results indicate that industry, leadership duality and directors' shareholdings are not significantly associated with sustainability reporting. The study is based only on the presence or absence of corporate sustainability disclosure without analyzing the quality aspects of sustainability disclosure which could lead to misinterpretation.

**Keywords** – Corporate disclosure, Determinants, Listed companies

## I. INTRODUCTION

Reporting on corporate sustainability activities is growing important for all kinds of organizations to show their commitment towards triple bottom line aspects namely; environmental, economic and social. The attention on triple bottom line issues has gained prominence as a result of recent corporate scandals occurred across the globe. In this context, pressure exerts by different stakeholders upon firms to behave socially acceptable manner has also increased. As a response to this pressure, firms are more likely to disseminate the sustainability information through sustainability reporting (Hahn & Kühnen 2013). A long line of empirical research has burgeoned over the recent decades, indicating corporate sustainability and related disclosures as being a function of firm characteristics (i.e. firm size, financial performance), internal contextual factors (i.e. board composition and expertise) and general contextual factors (i.e. culture, legal and political mechanisms) (Adams 2002). However, ample of the evidence to date on corporate disclosure is derived from developed capital markets (Bansal 2005; Reverte 2009; Kim et al. 2012; Giannarakis 2014) where the capital markets are mature and stakeholder awareness of corporate accountability is high (Kim et al. 2012; Giannarakis 2014; Reverte 2009). It documents that in light of evolving worldwide economic trends and the underlying dissimilarities in socio-cultural elements between the developed and emerging capital markets,

further research on corporate disclosures from an emerging capital market context is warranted (Muttakin & Subramanian 2015; Shamil et al. 2014). In contrast, emerging capital markets are still nascent while their regulatory, institutional and governance environments are weak. Thus, the impact of corporate governance systems on corporate disclosure is yet to be questioned. The review of literature on sustainability disclosure in developing nations sheds limited light on the above issue. Since there is a paucity of empirical evidence on the determinants of corporate sustainability (Lourenço & Branco 2013), this study is timely significant.

The intended aim of the present study is to identify the significant determinants of corporate sustainability disclosure. By using a sample of Sri Lankan data, the study explores the determinants of corporate sustainability disclosure. In particular, this study includes both firm characteristics and board characteristics on corporate sustainability information disclosed by companies listed in the Colombo Stock Exchange (CSE) over the sample period. The paper is structured as follows. The next section presents a review of literature on sustainability disclosure and its determinants followed by the hypotheses development. Subsequent section describes the research methodology, while the results and discussion of the study are presented in the fourth section. The last section highlights the conclusion along with suggestion for further research.

## II. LITERATURE REVIEW AND HYPOTHESES GENERATION

Sustainable development is an ethical concept related to struggling against poverty and safeguard the environment simultaneously and on a macro level (Baumgartner & Ebner 2010). When it incorporated by the firm, it is known as corporate sustainability, which covers three aspects of triple bottom line (Baumgartner & Ebner 2010; Lourenço & Branco 2013). The relevance of corporate sustainability disclosure in annual reports has encouraged in this regard (Janggu et al. 2014). Sustainability reporting is a very complex phenomenon which can hardly be defined by using a single theoretical approach (Cormier et al. 2005). Referring to the Brundland’s Report issued in 1987, corporate sustainability is defined as “development that meets the needs of the present without compromising the ability of future generations

to meet their own needs”(Montiel 2008; Janggu et al. 2014). Numerous studies have attempted to identify determinants of corporate disclosures, namely; corporate social responsibility (CSR) disclosure, corporate voluntary disclosure and corporate sustainability disclosure. Among those determinants, firm-specific characteristics and governance characteristics are considered important determinants of corporate disclosures (Aras & Crowther 2008). Table 1 summarizes a sample of recent literature reviews on determinants influencing the extent of corporate disclosure.

**Table 1. Main aspects of literature review**

Author/s	Sample Size	Year of reference	Research Method	Significance explanatory variables
Giannarakis (2014)	366 listed firms	2011	Multiple regression model	Firm size, Board size, CEO duality
Muttakin and Khan (2014)	116 listed firms	2005-2009	Multiple regression model	Firm size, Industry profile, ownership
Shamil et al., (2014)	148 listed firms	2012	Logistic regression models	Firm size, growth & age, Board size, Dual leadership
Lourenco and Branco (2013)	200 largest listed firms	2010	Logistic regression models	Firm size, Profitability, International listing, Ownership
Rao, Tili and Lester (2012)	100 largest listed firms	2008	Multiple regression model	Board independence, Females on board, Institutional investors, Board size
Khan (2010)	30 private commercial banks	2007-2008	Multiple regression model	Firm size, Profitability, Foreign nationalities on the board
said, Zainuddin and Haron (2009)	150 public listed firms	2006	Hierarchical regression model	Audit committee, Government ownership
Reverte (2009)	46 listed firms	2005-2006	Linear regression model	Firm size, Media exposure, Industry
Ho and Taylor (2007)	50 largest USA & Japanese firms	3003	Multiple regression model	Firm size, profitability, Liquidity, Industry and country
Haniffa and Cooke (2005)	139 listed firms	1996 and 2002	Multiple regression models	Firm size, Profitability, Industry, Multiple listing

**Source: Researchers’ conceptualization based on literature**

Table 1 indicates that number of firm specific and governance specific characteristics have become significant determinants that affect the corporate disclosures throughout the literature. The size of the samples ranges from 30 to 366 listed companies, probably because listed companies are more inclined to engage in sustainability and related initiatives in their business operations rather non-listed companies. In most of the studies, only one year was investigated, therefore, the results could not be generalized. As far as the determinants of extent of sustainability reporting disclosure are concerned, every researcher introduces different explanatory variables for studies. However, the most common determinants were the board diversity and the firm characteristics. The regression analysis was the dominant statistical tool used for the examination of the association between the dependent and the independent variables. In the present study, six firm characteristics, namely; firm size, profitability, leverage, firm growth, firm listing age and

industry profile along with six board characteristics, namely; board size, board independence, leadership duality, female directors on board, board ethnicity, and directors' ownership on sustainability reporting is investigated. The explanatory variables selected for this study are fairly similar to the prior research. This will therefore allow doing a comparison of the findings of the study with the previous findings.

Literature documents that profitability (Lourenço & Branco 2013; Zhang 2012; Hafsi & Turgut 2013), firm size (Lourenço & Branco 2013; Muttakin & Khan 2014; Shamil et al. 2014; Giannarakis 2014; Kiliç et al. 2015), leverage (Ho & Taylor 2007; Haniffa & Cooke 2005; Barako et al. 2006; Narges et al. 2014), firm growth (Artiach et al. 2010; Shamil et al. 2014), listing age of the firm (Narges et al. 2014; Shamil et al. 2014), industry (Haniffa & Cooke 2005; Barako et al. 2006; Narges et al. 2014; Muttakin & Khan 2014) as firm-specific factors which are commonly associated with sustainability and related disclosures. However, findings related to these variables are inconclusive. As the findings of prior studies are mixed, prior assumptions for the associations between corporate characteristics and sustainability disclosure cannot be made. Thus, the following non-directional hypotheses are tested:

- H<sub>1</sub> : Profitability is significantly related to sustainability disclosure.
- H<sub>2</sub> : Firm size is significantly related to sustainability disclosure.
- H<sub>3</sub> : Leverage is significantly related to sustainability disclosure.
- H<sub>4</sub> : Firm growth is significantly related to sustainability disclosure.
- H<sub>5</sub> : Listing age is significantly related to sustainability disclosure.
- H<sub>6</sub> : Industry is significantly related to sustainability disclosure.

et al. 2014). This is because, boards play an important role in determining the firm's strategic direction, such as implementing best practices, developing policies aimed at increasing stakeholder engagement and advancing corporate transparency (Frias-Aceituno et al. 2013). The supportive theoretical perspective on this idea is the agency theory, which describes the owner-agent relationship. Board of directors as the internal governing body of a firm assists to mitigate the conflict of interest between two parties. This monitoring mechanism enhances the quality of corporate disclosures and transparency while mitigating agency problems and reducing agency costs (Jensen & Meckling 1976; Fama & Jensen 1983). Consistent to this notion, previous studies have found board size (Ntim & Soobaroyen 2013; Said et al. 2009; Shamil et al. 2014; Frias-Aceituno et al. 2013; Janggu et al. 2014), board independence (Kiliç et al. 2015; Muttakin et al. 2015), dual leadership (Shamil et al. 2014; Giannarakis 2014), women on board (Glass et al. 2015; Hafsi & Turgut 2013; Frias-Aceituno et al. 2013), board ethnicity (Ntim & Soobaroyen 2013; Hafsi & Turgut 2013; Zhang 2012) and directors' ownership (De Villiers et al. 2011) to be significant drivers of corporate disclosures. Although findings are inconclusive, a large body of literature reports a significant positive association between board characteristics and corporate sustainability reporting. Thus, the following directional hypotheses were developed.

- H<sub>7</sub> : Board size is positively and significantly related to sustainability disclosure.
- H<sub>8</sub> : Board independence is positively and significantly related to sustainability disclosure.
- H<sub>9</sub> : Dual leadership is positively and significantly related to sustainability disclosure.
- H<sub>10</sub> : Female directors on the board is positively and significantly related to sustainability disclosure.
- H<sub>11</sub> : Board ethnicity is positively and significantly related to sustainability disclosure.
- H<sub>12</sub> : Directors' ownership is positively and significantly related to sustainability disclosure.

In recent years, the attention on board characteristics on corporate disclosure has become prominent. Especially, the corporate governance-sustainability nexus has received much attention (Aras & Crowther 2008; Amran

### III. RESEARCH METHOD

The sample for the study was selected from companies listed in CSE in Sri Lanka from 2012-2016. The final sample consist of 880 firm-year observations covering the years 2012-2016. This sample represents all the business sectors which cover 75 percent of the population (295 companies listed as at 30th September 2016). The remaining companies were excluded because of missing data. The required data for the analysis was extracted using content analysis from annual reports of the companies. The availability of the published sustainability reports was sourced from annual reports and company websites. In order to test the hypotheses formulated in the above section, selected variables are operationalized. Table 2 presents details of these variables.

Dependent variable Sustainability reporting (SR)	0 = Firm does not publish a sustainability report 1 = Firm publishes a sustainability report
Independent variables Firm-specific variables Profitability (ROE) Firm size (FSZ) Leverage (LEV) Firm growth (MB) Firm listing age (AGE) Industry (IND)	Return on equity (ROE) Natural log of total assets/Book value of equity Total debt/ Total assets Market value of shares/Book value of equity Number of listed years 0 = Non-sensitive 1 = Sensitive industries
Board-specific variables Board size (BSZ) Board independence (BIND) Dual leadership (DL) Female directors on board (FDB)  Board ethnicity (BE) Directors' shareholding (DS)	Number of directors Proportion of independent directors 0 = Chairman and CEO roles are combined 1 = Chairman and CEO roles are separated 0 = Boards without women directors 1 = Boards with women directors 0 = Homogeneous 1 = Heterogeneous Directors' share/ Total number of shares issued

Source: Researchers' conceptualization

In order to test the hypotheses, Binary logistic regression was selected. This method of analysis was selected because the study consists a binary dependent variable along a mixture of continuous and categorical variables. Initially, the impact of corporate characteristics and board characteristics on dependent variable was separately tested and then the both characteristics were entered to perform the full logistic regression analysis. Accordingly, three logistic regression models were tested.

Model 1:

$$\text{Logit } [P(\text{SR})] = \ln \{P(\text{SR}) / [1 - P(\text{SR})]\} = \beta_0 + \beta_1 \text{ROE} + \beta_2 \text{FSZ} + \beta_3 \text{LEV} + \beta_4 \text{MB} + \beta_5 \text{AGE} + \beta_6 \text{IND} + \epsilon_1$$

Model 2:

$$\text{Logit } [P(\text{SR})] = \ln \{P(\text{SR}) / [1 - P(\text{SR})]\} = \beta_0 + \beta_7 \text{BSZ} + \beta_8 \text{BIND} + \beta_9 \text{BLD} + \beta_{10} \text{BFD} + \beta_{11} \text{BE} + \beta_{12} \text{DS} + \epsilon_2$$

Model 3:

$$\text{Logit } [P(\text{SR})] = \ln \{P(\text{SR}) / [1 - P(\text{SR})]\} = \beta_0 + \beta_1 \text{ROE} + \beta_2 \text{FSZ} + \beta_3 \text{LEV} + \beta_4 \text{MB} + \beta_5 \text{AGE} + \beta_6 \text{IND} + \beta_7 \text{BSZ} + \beta_8 \text{BIND} + \beta_9 \text{BLD} + \beta_{10} \text{BFD} + \beta_{11} \text{BE} + \beta_{12} \text{DS} + \epsilon_3$$

Where  $\epsilon$ 's are random errors and  $\beta$ 's are coefficients of models,  $i = 1, 2, 3$  and  $j = 1, 2, \dots, 12$ .

### IV. RESULTS AND DISCUSSION

Table 3. Results of descriptive statistics

Variable	Mean	SD
Sustainability reporting	0.63	0.48
ROE (%)	8.82	35.08
Firm size (Ln)	22.05	1.60
Leverage	0.41	0.30
MB ratio	2.05	4.70
Listing age	25.79	16.96
Industry	0.45	0.50
Board Size	7.93	2.16
Board independence	0.40	0.14
Board leadership duality	0.85	0.36
Board with female directors	0.46	0.50
Board ethnicity	0.77	0.42
Directors' shareholding (%)	8.74	17.77

The dependent variable sustainability reporting has a mean of 0.63 indicating that 63 percent of the sample firms are publishing sustainability reports that is generally high. The mean of natural log of total assets, leverage and market to book ratio are 22.05, 0.41 and 2.05, respectively. The average of profitability (ROE) is 8.82 percent while, listing age of firms in the sample is 26 years. The mean of the industry points out that 45 percent firms in the sample represent the environmental sensitive sectors, which concerns about sustainability. The average of board size is 7.93, which is comparable to the mean board size reported for listed firms in Sri Lanka (Shamil et al. 2014; Wijethilake et al. 2015). The mean of board independence is 0.40, indicating that the proportion of independent directors represents only 40 percent out of total board of directors in the sample firms. It is interesting to note that 85 percent of the sample firms have separated the roles of CEO and chairman. The average of boards with women directors indicates that 46 percent firms of the Sri Lankan listed firms have at least one female director. Furthermore, 77 percent of the firms in the sample consists by board ethnicity while average shareholding of the board of directors in the sample firms is only 8.74.

Table 5 presents the results of the logistic regression models.

**Table 4. Logistic regression models results**

	B	SE	Wald	Sig	Exp(B)
<b>Model I</b>					
Intercept	-21.606	1.878	-11.503	0.000	0.000
ROE	0.009	0.003	2.594	0.009	1.009
FSZ	1.023	0.088	11.689	0.000	2.781
LEV	0.712	0.345	2.064	0.039	2.038
MB	0.088	0.045	1.952	0.051	1.092
AGE	-0.028	0.005	-5.168	0.000	0.972
IND	0.181	0.173	1.045	0.296	1.198
AIC	847.71				
<b>Model II</b>					
Intercept	-3.540	0.477	-7.422	0.000	0.029
BSZ	0.369	0.042	8.775	0.000	1.446
BID	2.075	0.585	3.545	0.000	7.964
BLD	0.131	0.212	0.621	0.535	1.140
BFD	-0.291	0.153	-1.899	0.057	0.748
BE	0.591	0.176	3.360	0.001	1.806
DS	-0.003	0.004	-0.810	0.418	0.997
AIC	1045				
<b>Model III</b>					
Intercept	-22.270	2.030	-11.183	0.000	2.129
ROE	0.008	0.003	2.778	0.005	1.008
FSZ	0.928	0.091	10.188	0.000	2.529
LEV	1.082	0.365	2.967	0.003	2.951
MB	0.092	0.047	1.968	0.049	1.096
AGE	-0.031	0.006	-5.381	0.000	0.969
IND	0.239	0.190	1.263	0.206	1.267
BSZ	0.296	0.049	6.054	0.000	1.344
BID	1.671	0.730	2.288	0.022	5.317
BLD	0.004	0.253	0.149	0.881	1.004
BFD	-0.564	0.185	-3.041	0.002	0.569
BE	0.477	0.211	2.263	0.024	1.611
DS	-0.000	0.005	-0.042	0.967	0.000
AIC	800.59				

Notes : n = 880, B = estimated coefficient, SE = standard error, Exp(B), odds

Model 3 which includes all the variables, reports the minimum Akaike Information Criterion (AIC), hence Model 3 is the most preferred model for the given set of data. The p-values of deviances are zero of each model in this study. Thus, this indicates that the models used in this study appear to have performed quite well, showing a significant reduction in deviance. Based on the results given in model 3, hypotheses were tested. Accordingly, the Wald statistic of firm size, firm age and board size are significant at 0.001, the Wald statistic of ROE, leverage and boards with female directors are significant at 0.01 and firm growth (MB), board independence and board ethnicity are significant at 0.05. Therefore, the null hypotheses that the coefficients of these variables equals 0 ( $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_7 = \beta_8 = \beta_{10} = \beta_{11} = 0$ ) is rejected. Thus, alternative hypotheses related to these variables are accepted. These findings are more consistent with the findings of similar studies (Muttakin et al. 2015). The negative coefficient of firm age suggests that newly listed firms are more likely to produce sustainability reports than old listed firms. Study by Shamil et al. (2014) has reported similar evidence that younger firms are more willing to disclose sustainability reports in Sri Lanka. Coefficient of women on board indicates a negative relationship with sustainability reporting. This finding is consistent with finding of Muttakin et al. (2015) and Shamil et al. (2014). A possible reason for this negative association may be a reason suggested by Muttakin et al. (2015). They argue that “from a cultural perspective, the role of female directors can be constricted in developing nations” (p. 359). Thus, findings suggest that the direction of H10 is negative. However, Industry, leadership duality and directors’ shareholding are not significant determinants of sustainability disclosure, suggesting that there is no evidence to support H6, H9, and H12 proposed in the study. Previous study carried by Haniffa and Cooke (2005) also reported that the industry had no significant association with corporate disclosure, while Said et al. (2009) reported that CEO duality and directors’ share ownership were insignificant determinants of corporate disclosure.

## V. CONCLUSION AND FURTHER RESEARCH

This study attempted to investigate the factors that determines the sustainability reporting disclosure among listed companies in the CSE in Sri Lanka. Both firm characteristics and board characteristics have been

considered in this regard. The sample was drawn from listed companies because these firms are more possible to adopt sustainability and related initiatives into their business operation than non-listed firms. Result of Logistic regression showed that profitability, firm size, leverage, firm growth, board size, board independence, board ethnicity significantly and positively associated with sustainability disclosure, whereas firm age and board with female directors significantly but negatively associated with the dependent variable. Finally, a significant influence did not report in relation to three determinants, namely; industry, leadership duality and directors' shareholding. Empirical evidence provided in this study suggests that firm and board characteristics have played a pivotal role in the corporate disclosure decision. Thus, it appears to be beneficial for Sri Lankan listed companies to strengthen the corporate governance mechanism while paying special attention on corporate characteristics. The main limitation of this study is the operationalization of the dependent variable as a dichotomous which does not provide insight on the quality of sustainability reporting. Thus, this limitation warrants further studies in terms of insight on the quality of sustainability reporting.

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# IMPACT OF HUMAN RESOURCE PRACTICES ON ENTERPRISE PERFORMANCE IN SMALL AND MEDIUM-SIZED ENTERPRISES OF SRI LANKA

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**Abstract** - Human resource management (HRM) is a new concept for Sri Lankan Small and Medium-scale enterprises (SMEs); there are few studies on HRM practices and its impact on enterprise performance in Sri Lankan SMEs. The investigation of the impact of human resource management and the enterprise performance has mostly been carried out in big companies only. The objectives of the study were to address the linkage between HR practices and enterprise performance, and to identify the impact of HR practice on enterprise performance in contemporary SMEs in Sri Lanka. The response rate was 67.8% which represented 144 manufacturing SMEs in the Western Province of Sri Lanka. The study employed a categorized questionnaire for owner-managers of SMEs. Stratified sampling technique was applied to obtain the sample size of the study. Cronbach alpha, descriptive statistics, Pearson correlation coefficient and Multiple Regression were used for various analyzes of this study. The findings of the research revealed that Human Resource Management practices positively influence on the performance of SMEs. The results of this study revealed that Recruitment/Selection, Training/Development, Performance Appraisal and Reward/Compensation were independently and positively correlated with Enterprise Performance. Correlation analysis showed that HRM practices had a positive relation with enterprise performance. The maximum correlation ( $r=0.703$ ) existed between Reward/Compensation and Enterprise Performance, followed by the association ( $r=0.672$ ) between Training/Development and Enterprise Performance; Recruitment/Selection and Enterprise Performance ( $r=0.654$ ); and Performance Appraisal and Enterprise Performance ( $r=0.634$ ).

The study also found that RNS, TND, PA and COM are positively related to enterprise performance with adjusted  $R^2$  of 60.6 and F-value 47.173 ( $p<0.01$ ). RNC and enterprise performance had the strongest effect on enterprise performance with a standardized beta of 2.81. This study found that HRM practices are also positively related to better enterprise performance.

**Key words** - Human Resource Management, Small and Medium enterprises, Human Resource Practices

## 1. INTRODUCTION

Small and medium-scale enterprises (SMEs) are considered as a significant component for the development of economies (Ayyagari, Demirguc-Kunt, & Maksimovic, 2011; Kongolo, 2010). The relevant statistics for many countries show that the SMEs are predominant in the economy by representing more than 99 per cent of the companies (Tayebi, Razavi, & Zamani, 2011). The contribution of SMEs in developed economies has been evidenced through a number of previous studies. Cross country evidence gathered from multiple sources by the Edinburgh Group of Kingston Business School (2015) reflects the importance of SMEs in the global economy. Their report points the need of financial and non-financial resources in order to support the SME sector, while highlighting the importance of SMEs in the global economy. Research of Kachembere (2011) noted that SMEs are playing a pivotal role in promoting economic growth, sustainable development and so it is crucial to

employment creation opportunities. [For example, in Asia, SMEs are accountable for up to 50 per cent of all jobs, mainly in the private sector (Hall, 2002; Tambunan, 2011)]. According to the United States Small Business Administration (USSBA), 99.7 per cent of US firms are categorized as small (less than 500 employees). Thus, the importance of SMEs to a developed economy can be demonstrated in this case of the US. Moreover, small businesses have been totaled to 27.3 million in 2008, and they accounted for 49.6 per cent of private sector jobs in the US (USSBA, 2011). SMEs are defined by the European economy as having less than 250 employees. In 20 million EU enterprises, more than 99 per cent of firms are SMEs and they offer 80 million jobs in the European economy (Ceranac & Popovic, 2009).

Not only in developed economies, but also in developing economies, SMEs are seen to play an important role in the economic development. They play a major role in poverty reduction by means of employment generation. Lukacs (2005) states, “in much of the developing world, the private economy is almost completely includes SMEs and they generate employment opportunity for millions of poor people all over the world” (p.10).

Thus, SMEs have become an important factor in the developing economies in the world, especially to the economies like Sri Lanka. It contributes largely to the socio economic stability and poverty reduction process of Sri Lankan economy in terms of employment generation while contributing to the GDP, equitable distribution of income, embarking on innovations, balancing regional development, lowering transaction cost and inspiring other economic activities. The SMEs cover wide-range of areas of economic activity such as agriculture, mining, manufacturing, construction and service sector industries (White Paper, 2002). Besides, SMEs provide a strong foundation for large enterprises of the future, as most of large enterprises today, have been initiated as SMEs in the past. (e.g. Toyota, Honda, and Sony originally began as small family businesses in Japan [Sato, 2013]).

Table 1.1 shows the contribution of the SME sector to the national economy of Sri Lanka in terms of number of establishments and persons engaged. According to the table 1.1, there are 1,019,681 registered and informal industrial units in the country producing various types of products and employing 3,003,119 persons.

**Table 1.1: Distribution of persons engaged and establishments across SME groups in Sri Lanka**

	No. of Establishments		Persons Engaged	
	Number	%	Number	%
Total	1,019,681	100.0	3,003,119	100.0
Micro	935,736	91.8	1,338,675	44.6
Small	71,126	7.0	529,751	17.6
Medium	10,405	1.0	386,756	12.9
Large	2,414	0.2	747,937	24.9

*Source: Department of Census and Statistics – Industrial Survey (2013/14)*

**1.1. Research questions**

Specifically, this study was undertaken to explore the answer to the following research questions:

1. Is there any association between HR practices and Enterprise Performance?
2. Do HR practices have any impact on Enterprise Performance ?

**1.2. Objectives**

The main purpose of the study was to identify the impact of HR practices on enterprise performance. In order to materialize this objective, the following specific objectives were considered.

1. To address the linkage between HR practices and enterprise performance.
2. To identify the impact of HR practices on enterprise performance.

**II. LITERATURE REVIEW**

**2.1. Working definition of me for the study**

With reference to Department of Census and statistics of Sri Lanka (2016), the following working definition of SME is adopted for the study:

1. SMEs in manufacturing industry will mean enterprises having asset values not exceeding SLRs. 50 million, excluding lands and buildings.
2. SMEs in manufacturing industry will mean the small

and medium size establishments that employ between 5 and 199 people.

3. SMEs will mean those enterprises whose share is not listed with stock exchange.
4. SMEs shall not include those enterprises which are involved with professional activities like doctors, lawyers etc.
5. SMEs will mean those enterprises which are operating in private sector.
6. SMEs will mean those enterprises that are engaged in business operation.

## 2.2. Hrm and sme performance

Only limited studies (Nguyen & Bryant, 2004; Welbourne & Andrews, 1996) have been concentrated the relationship between adoption of HRM practices and SME performance. Research describes severe shortage of recognizing and validating human resource practices in small firms, and even a smaller amount research focusing on the relationship between strategy, human resource practices, and small firm performance (Chandler & McEvoy 2000).

Most studies of HRM in SMEs has focused on comparing HR practices in small and large firms (for example, Golhar & Deshpande, 1997; Hornsby & Kuratko, 2003; McEvoy, 1984; Watson et al., 1994), where the emphasis was more exclusively upon the investigation of HRM issues in SMEs, there was often a concentration upon identification of problems in the areas of selection, recruitment, compensation, empowerment, training and the role of trade unions (see, for example, De Kok & Uhlaner, 2001; Rainnie, 1989; Szamosi et al., 2004; Wyer & Mason, 1999). Several studies have examined the impact of management training on SME performance (Marshall et al., 1995; Westhead & Storey, 1996; Wong et al., 1997), but the results have showed only a weak relationship between management training and SME performance. It is critical to note that research has recommended that smaller organizations present a “sole opportunity for studying human resource management” and its relation to firm performance (Welbourne & Andrews, 1996).

Delery and Doty's (1996) contingency approach describes that the relationship between the significant independent variable and the dependent variable will differ relevant to

such influences as company size, company age, technology, capital intensity, the degree of unionization, industry/sector, ownership and location. However, where there was an emphasis upon SMEs, such studies inclined to observe the existence of HRM practices without investigative the impact of the HRM practices on firm performance. While there has been very little research into the performance effects of HRM implementation on SMEs, a common trend in the arguments offered in previous studies on HRM in SMEs is that as SMEs grow, inexperienced people management approaches become increasingly insufficient (Kaman et al., 2001; Kotey & Slade, 2005; Zheng et al., 2006). When this happens, SME owners-managers may come to understand the importance of formally adopting HRM systems and the related benefits of nurturing people's creativity, and even the creation of competitive advantage, development and success through individuals (Bacon et al., 1996; Kaman et al., 2001; Kotey & Slade, 2005; Zheng et al., 2006).

Although it shows the importance of HRM among SMEs, the empirical evidence on the level of the impact of HRM practices on SME performance is undetermined (Zheng et al., 2006). And there is no empirical testing in the situation of Sri Lankan SMEs.

**Hypothesis 1: HR practices have significant association with enterprise performance:**

**Hypothesis 2: HR practices have significant impact on enterprise performance:**

## 2.3. Relationship between hrm practices and enterprise performance

2.3.1. Recruitment/selection and enterprise performance; In the context of SMEs employee recruitment/selection is an often studied HR component. Though SMEs could lack legitimacy as an employer, in comparison to training, staffing is a low cost means to improve the quality of employees (Cardon & Stevens, 2004). Wright et al. (2005) defined formal recruitment/selection as conducting prearranged interviews and formal tests of applicants through the hiring procedures. Generally, large firms have more formal hiring processes because applicants that are selected by large firms have to undertake interviews with professional recruiters (Dyer & Reda, 2010). Furthermore, larger firms can make use of a wider range of hiring channels as they have more resources at their disposal (Wilkinson, 1999). SMEs use recruitment and selection techniques more

than any other HR practice (Cassell et al., 2002). Despite that, recruitment/selection has been recognized as SMEs' weakest HRM practice (Barrett & Mayson, 2007). Moreover, SMEs have tolerated problems on recruiting capable employees, because they apply less attractive hiring channels, such as newspaper advertisements and walk-ins, in contrast to online advertisements and external recruitment agencies used by large firms (Bacon & Hoque, 2005). It has been stated that the most common recruitment/selection technique used by SMEs is word of mouth, as it is a low-cost method of attracting candidates (Barrett & Mayson, 2007). However, it has been specified that cost-effective recruitment/selection for SMEs wants at least a clear job description (Sun, Aryee, & Law, 2007).

**Hypothesis 3: Recruitment and selection positively influences on enterprise performance:**

2.3.2. Training/Development and enterprise performance; In accordance with Chandler and McEvoy (2000), consistent employee training has a positive influence on an individual worker's productivity. Rationally, developments in individual productivity will lead to increased organizational performance (Wright, Gardner, Maynihan, & Allen, 2005). Further, Chandler and McEvoy (2000) mentioned that training offers socialization and skills required for an employee to increase productivity and quality.

Looking from an HRM perspective, large firms are usually provided formal training to employees on a yearly basis and consist personal development opportunities (Wright et al., 2005). On the other hand, providing formal training to employees is a problem for SMEs since it is highly costly (Mayson & Barrett, 2006). Cassell, Nadin, Gray and Clegg (2002) mentioned that employees in SMEs are less likely to obtain a proper, designed training compared to larger firms. Furthermore, SMEs have frequently experienced difficulty in terms of identification the needs to train employees (Chi et al., 2008). Maybe this lack of need identification is due to the organizational structure of SMEs, as pointed out by Sun, Aryee, and Law (2007), asserting that SMEs provide less internal promotion opportunities compared to large organizations. The probability to gain an internal promotion leads to employees' motivation, in turn it leads to improve their skills and to managers' opportunity to train their employees (Sun, Aryee, & Law, 2007). Kotey and Folker (2007) emphasized the informality of employee training in SMEs, how it is unplanned, has minimal provision and is short-term oriented.

**Hypothesis 4: Training and development positively influences on enterprise performance:**

2.3.3. Performance Appraisal and enterprise performance; Performance appraisal is a systematic process to evaluate the performance of an employee after certain period (Schuler, 1981, p. 211). Performance appraisal also influences other HR practices such as recruitment and selection, training and development, compensation, and employee relations. As performance appraisal leads to pay raise, promotion, and training; it is assumed that better performance appraisal can have impact on organizational performance.

Bdemardin and Russel (1993) argued that wider communication of performance appraisal policies within enterprise is essential to make employees clear about their specific role expected as contribution in enterprise performance. Lee and Lee (2007) found that effective performance appraisal system increase productivity, and quality. Sang (2005) also established that a comprehensive, fair and customer's focused performance appraisal system increase enterprise performance. Similarly, Rahman (2006) found that comprehensive performance appraisal enhance employees' commitment which enhances their performance.

Murphy and Cleveland (1995) believe that performance appraisals can help enterprises in four ways. Firstly, they can enhance the quality of enterprise decisions, ranging from promotions, layoffs, compensation and transfers. Second, they can enhance the quality of individual decisions, ranging from career choices to decisions about where to direct one's time and effort. Third, they provide a set of tools for enterprise diagnosis and development. Finally, performance appraisals can affect employees' views of and attachment to their enterprise. Performance appraisal is a tool of management that can lead to better communication, motivation, and feedback (Stivers & Joyce, 2000).

**Hypothesis 5: Performance appraisal positively influence on enterprise performance:**

2.3.4. Reward/Compensation and enterprise performance; Employee compensation is another part of HRM that is vital in contributing to a firm's success (Collins & Smith, 2006; Dunn, Short, & Liang, 2008). Irrespective if it is a group or individual reward, compensation can drive the determination of employees to act in their firm's best

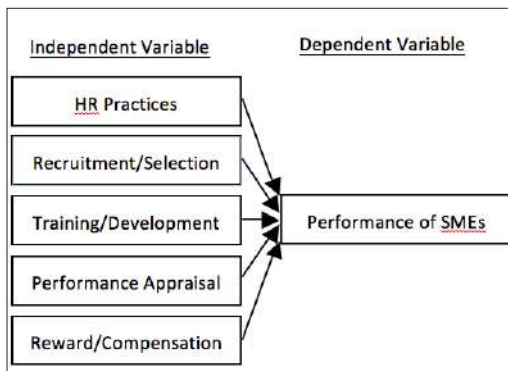
interest. A formal performance appraisal that results in compensation is likely to boost a firm's performance (Chandler & McEvoy, 2000; Sun, Aryee, & Law, 2007).

Large firms have typical and centralized HRM techniques to compensate employees (Dyer & Reda, 2010). In general, employees get a yearly formal evaluation of their performance and have the opportunity to earn bonuses based on individual performance (Wright et al., 2005). A monthly feedback system is another example of a formal HR practice (Hudson, Stuart, & Bourne, 2001). This formal appraisal process can boost employees' motivation (Subramony, 2009).

Instead, informal and uncoordinated compensation procedures are applied by SMEs to reward their employees (Mayson & Barrett, 2006). Compensation is different in SMEs, in the sense that SMEs have a greater focus on non-financial rewards, such as educational benefits and recreational facilities (Cardon & Stevens, 2004). By doing so, reward/compensation for workers become more complex. Additionally, compensation acquires more costs for SMEs, which is why it is applied on an infrequent basis (Wright et al., 2005).

**Hypothesis 6: Compensation positively influences on enterprise performance:**

**2.4. Conceptual framework**



**Figure 2.1: Conceptual Framework**  
 Source: Researcher's construction

**III. RESEARCH METHODOLOGY**

Research Methodology of the present study was outlined below.

**3.1. Study population**

The target population of this study covers the manufacturing SMEs in the Western Province of Sri Lanka and the main reason for selecting the manufacturing sector SMEs are they account for 96 per cent of the manufacturing sector in Sri Lanka (White Paper, 2002). The enterprise survey database (2013) maintained by the Department of Census and statistics of Sri Lanka was used as the sample frame of the study due to its wide coverage and reliability of data. Colombo, Gampaha and Kalutara are the main three districts belonged to the Western Province. According to the Department of Census and Statistics, 2013/14 there is 42 per cent of SMEs located in the Western Province. Considering the added values to the Gross Domestic Product four leading industries are selected from the SME sector namely; manufacturing of food products and beverages, manufacturing of textiles, manufacturing of wearing apparel, dressing and dyeing, and manufacturing of Rubber and Plastic products (Department of Census and Statistics, 2013).

**3.2. Sample and sample techniques**

A sample of 286 is selected from the target population. The sample size obtained from the above is allocated to four sectors by using stratified sampling technique. For selecting respondent to the sample, proportional stratified sample technique was used. Here, the size of each stratum in the sample is proportionate to the size of the stratum in the population.

**3.3. Data sources and instruments**

This study was compiled with the help of primary data and secondary data. Questionnaire survey method was used to gather primary data in the present study. A item and a 05 item Likert type questionnaire (where 1= strongly disagree to 5= strongly agree) were developed with some modifications from earlier studies (Becker & Huselid,1998) to measure the HR practices and enterprise performance of SMEs. Moreover, the desk study covered various published and unpublished materials on the subject.

3.4. Reliability and validity

Before applying statistical tools, testing of the reliability of the scale is very much important as it shows the extent to which a scale produces consistent result if measurements were made repeatedly. This is done by determining the association in between scores obtained from different administrations of the scales. If the association is high, the scale yields consistent result, thus is reliable. Cronbach's alpha is most widely used method.

Table 3.1 shows the Cronbach's Alpha values for both dependent and independent variables which are considered to be acceptable. According to Sekaran (2003), reliabilities with less than 0.60 are deemed poor while those in the range of 0.70 ranges, is acceptable and those above 0.80 is considered as good. On the over all, the reliability of all the measures was comfortably above 0.70, ranging from 0.75 to 0.89. The alpha shown shows a strong level of internal consistency reliability. It also indicates the scale used can fully be relied upon.

Table 3.1: Reliability statistics on variables

Variables	No.of Items	Cronbach's Alpha
Recruitment/Selection	8	0.895
Training/Development	10	0.837
Performance Appraisal	8	0.762
Reward/Compensation	9	0.757
Enterprise Performance	7	0.807

Source: Calculated with the researchers survey data

IV. DATA ANALYSIS AND FINDINGS

In the present study, data were analysed by an enter wise method in a multiple regression analysis.

In this context, a multiple regression was performed, by making use of all the discrete variables (dependent and independent variables) available in the dataset. The estimation process was based on Ordinary Least Square (OLS) [i.e. = a +bx]. For this purpose, the researcher consider the following model specifications by taking as dependent variable (Enterprise Performance) by making HR practices as independent variables.

$$EP = \beta_0 + \beta_1 (RNS) + \beta_2 (TND) + \beta_3 (PA) + \beta_4 (RNC) + e \dots \text{Model (1)}$$

Where,  $\beta_0, \beta_1, \beta_2, \beta_3, \beta_4$ , are the regression co-efficient

- EP = Enterprise Performance
- RNS = Recruitment/Selection
- TND = Training/Development
- PA = Performance Appraisal
- RNC = Reward/Compensation
- E = error term

To test how well the mode-1 fit the data and findings, correlation (r), R, R2 (Coefficient of determination), variance, analysis of variance (ANOVA) and the t statistic were used. Correlation analysis was performed to find out the pair wise relationship between variables; RNS, TND, PA, COM, and OP. Hence, the results are summarized in table.4.1.

Table 4.1: Correlation of HRM practices with enterprise performance

		RNS	TND	PA	RNC	EP
RNS	Pearson Correlation	1	.692**	.535**	.672**	.654**
	Sig. (2-tailed)		.000	.000	.000	.000
	N	194	194	194	194	194
TND	Pearson Correlation	.692**	1	.606**	.672**	.672**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	194	194	194	194	194
PA	Pearson Correlation	.535**	.606**	1	.679**	.634**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	194	194	194	194	194
RNC	Pearson Correlation	.672**	.672**	.679**	1	.703**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	194	194	194	194	194
EP	Pearson Correlation	.654**	.672**	.634**	.703**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	194	194	194	194	194

\*\* Correlation is significant at the 0.01 level (2-tailed)

Table 4.1 shows that the factors RNS, TND, PA, and COM are independently positively correlated with EP and also highly significant at 1% levels. Therefore, Hypothesis 1 of the present study was accepted. Here it is obvious that the maximum correlation (r =0.703) is existed between RNC and EP, followed by the association (r =0.672) between TND and EP; RNS and EP(r= 0.654); and PA and EP (r =0.634). It should be needed to give the highest emphasis on RNC for superb EP. TND is also crucial for wonderful perceived enterprise performance followed by other HR practices (i.e., TND and RNS). HR practices are pair-wise positively correlated with one to another and also statistically significant at P-value 0.000. Among the four

HR practices, the relationship ( $r = 0.692$ ) between RNS and TND is the highest, followed by the link ( $r = 0.672$ ) between RNS and RNC.

Further, a multiple regression analysis was performed to identify the predictors of OP as conceptualized in the model. An enter-wise variable selection was used in the regression analysis and table 4.2 and table 4.3 show the summary measure and analysis of variance (ANOVA) of the model.

**Table 4.2: Coefficient of determination (R2)**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.779a	.606	.598	.2704017

**a. Predictors: (Constant), recruitment/selection, training/Development, Performance Appraisal and reward/compensation**

**Source: Calculated with the researchers survey data**

**4.3: Anova<sup>a</sup>**

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	14.334	4	3.584	47.713	.000b
	Residual	10.440	139	.075		
	Total	24.774	143			

**a. Dependent Variable: OP**

**b. Predictors: (Constant), RNC, RNS, PA, TND**

The HR practices (RNS; TND; PA; and COM) in the above model revealed the ability to predict OP ( $R^2 = 0.606$ ). In this model value of  $R^2$  denotes that 60.6 percent of the observed variability in EP can be explained by the HR practices namely RNS; TND; PA and COM. The remaining 42.1 percent is not explained which means that the rest 42.1 percent of the variation of EP is related to other variables which are not depicted in the model. This variance is highly significant as indicated by the F value ( $F=47.713$  and  $P < 0.01$ ) [For details please see table-4]. An examination of the model summary presented by the table 4.3 in conjunction with ANOVA, presented by the table 4.4, indicates that the model explains the most possible combination of predictor variables that could contribute to the relationship with the dependent variable. The table 4.4 shows that RNS, TND, PA and RNC is positively influencing on EP. The regression equation established

that taking all factors into account (recruitment/selection, training/development, performance appraisal and reward/compensation) constant at zero enterprise performance will be 1.087. The regression equation will be:

$$OP = 1.087 + 0.105 (RNS) + 0.157 (TND) + 0.198 (PA) + 0.247 (RNC)$$

**Table 4.4: Multiple regression analysis**

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	1.087	.160		6.803	.000
RNS	.105	.035	.206	3.006	.003
TND	.157	.051	.219	3.101	.002
PA	.198	.064	.201	3.106	.002
RNC	.247	.065	.281	3.802	.004

**a. Dependent Variable: OP**

**Source: Calculated with the researchers survey data**

**IV. CONCLUSION**

Human resource is required for an enterprise to conduct different business activities. Without the support of human resource the enterprise cannot exist or operate effectively. Success of any enterprise depends on the effective use of human resources. The medium scale sector has emerged as a dynamic and vibrant sector of the Sri Lankan economy. HR practices exist but are not formal and become formal as the size of the firm increases.

In this study it was dealt with resource management use the practices of human resource and their impact on SME performance that works in Sri Lanka. The study found overall support for the influence of human resource management practices namely RNS, TND, PA and RNC on enterprise performance.

Using the human practices help SME to improve their performance from the study resulted that reward and compensation is the most profitable practice of SME, which increases more the performance. But even the other three practices that were the objectives of the study showed positive influence in firm performance, therefore it came to conclusion that using formal practices raises SME performance.

## V. RECOMMENDATIONS

Human resources, which are measured as the greatest advantage of an organization, refer to people whose knowledge, skills, and abilities are utilized to create and to deliver effective services.

Irrespective of size and volume of business of the unit, institution of proper HR policy would weed out the majority of human resources related problem, The HR policies facilitate prompt actions in respect of HR decision, consistency of action in the place of whimsical action and freedom from personal bias. Therefore all units will do well to chart out clear out HR policy.

SMEs need to have an effective recruitment policy to promote scientific selection of prospective employers. The departments should participate in selection process as they have different preferences in the candidates. Candidates need to be selected based on requisite skills knowledge, attitude and qualification using appropriate selection techniques. Besides, appropriate training programme for employees should be organized to continuously improve the skills of employees.

Moreover, a training and management development programme should be implemented to enhance the capabilities of employees of MEs. Investing in the improvement of the knowledge and skills of employees would enable SMEs to develop more productive and effective employees.

Furthermore, performance appraisal should be guided by the performance management policy. Employee's performance should be assessed based on quantifiable standards and feedback be given to employees on their performance. The appraisal system should be explicitly described specific purpose of the appraisal. Organizations that clearly state the purpose for the appraisal reduce the confusion and ambiguity of the process. The goal should be that everyone knows why to conduct appraisals.

Performance- related compensation is critical in enhancing performance; hence the organization should implement this to motivate those employees who achieve the set targets. Since HRM practices have a significant impact on organizational performance, managers need to implement them in an integrated and coherent manner (Chen et al., 2009; Wickramasinghe & Gamage, 2011).

This study has an addition to earlier research efforts in understanding the relationship between organizational performance and HRM practices. The study provides new dimensions in the research of management by opening a debate on the importance of HRM practices in organizational performance. Statistically significant correlations and regression results were indicated that different HRM practices, such as recruitment/selection, training/development, performance appraisal and reward/compensation system are significantly related and make positive contributions towards perceived enterprise performance.

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# IDENTIFYING THE IMPACT OF BANKING PRODUCTS TO GREEN BANKING INITIATIVES: CASE STUDY FOR A STATE BANK

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**Abstract** – Being part of the global trend banks have started moving towards the green banking concept through reducing their internal resource usage and being a key influencer for business entities to follow green initiatives. However banks being in the service industry, customer perception and acceptance become critical in whatever change they do. State bank in focus with a number of digital products offered to customers, has no evidence to judge what impact those products creates on green banking initiatives of the bank. This research therefore addresses the knowledge gap that exists, which then provide useful insights for the management to develop strategies in promoting green banking initiatives of the said bank. The study aimed to identify the impact of banking products of the said bank towards implementing its green banking initiatives, identify the most important banking products of the bank in implementing green banking and analyse the most effective means of making customers aware of green banking initiatives of the bank. Critical literature review allows identifying, green lending, e-accounts, internet banking, cash deposit machines (CDMs) and electronic payment cards as important factors to be tested against green banking initiatives of the bank. Co-relation between the above independent variables and the dependent variable were then tested. Hypotheses were tested based on co-relations established on data analysis. The research collected data from 124 respondents through a self-administrated questionnaire.

Results revealed all factors tested are significant and moderate to strong positive co-relation to green initiatives of the bank. However e-accounts identified among them create the highest impact (47.7%) on implementing green initiatives across the bank. It has also found television

advertisements as the most effective means of promoting green initiatives of the bank. The study concludes all the factors tested have a positive impact on green banking initiatives of the state bank.

**Keywords** - Green banking, Green initiatives, Green lending, Paper-less banking

## I. INTRODUCTION

Green economy has gained much importance in today's world due to resulting environmental degradation and climate change. As a result environmental pressure groups, NGOs and other civil societies are urging governments and responsible corporate citizens to take urgent steps to safeguard the environment for present as well as for future generations.

The term “green” refers to a broad concept of sustainable development and ethical business where optimum level of efficiency is achieved in business operations through least resource consumption and minimal harm to the environment. Green concept has received much attention after United Nations sustainable development goals (SDG) which was adopted in September 2015 where 7 goals out of 17 sustainable development goals are on achieving environment sustainability.

State bank in concern being concern on above facts, has decided to take a lead in green banking alone with its process of transforming its processes, products and services into environmental friendly alternatives. The

initiatives have already taken through steps such as digitization, green product development, lending for environmental friendly projects and renewable energy plant installation.

Although the state bank has introduced many digital products in order to implement green initiatives, yet the actual impact of those products in achieving green initiatives are not known. However being in service sector customer acceptance on these new products is vital. Also it is important for the bank in developing their operational and marketing strategies. Study therefore analyse what impact the banking products of the selected state bank has towards implementing green banking initiate across the bank, with the objectives of identifying the impact of banking products of the bank towards implementing its green banking initiatives, identifying the most important banking products of the bank in implementing green banking and analyse the most effective means of making customers aware on green banking products and services of the bank.

## II. METHODOLOGY

Self-administrated questionnaire was used for primary data collection. The target population consist of 62,156 customers of the Western province area 1 of the super grade branches of the selected state bank .The sampling technique used is cluster sampling method. The sample size was 400. Although the researcher distributed 400 questionnaires, due to time and resource constrains only 124 completed respondents were received back. Past literature were reviewed in developing the conceptual framework of the present study. Based on the critical literature review it found 78% of the past literature reviewed had discussed on green lending as an factor on green banking (Bahl, 2102; Biswas, 2011;Girish, 2016; Nayak and Geol, 2014; Singhal, Singhal and Arya, 2014; Sudhalakshmi and Chinnadorai, 2014 and Verma, 2012). Internet banking was found to be the next highest discussed factor (Bahl, 2102; Choudhury and et al, 2013; Girish, 2016; Nayak and Geol, 2014; Singhal, Singhal and Arya, 2014 and Sudhalakshmi and Chinnadorai, 2014). Hence as per the factor analysis done as mentioned above, Green lending, E-Accounts, CDMs, Internet banking and Electronic payment cards were identified as the independent variables to be tested against green banking initiatives of the state bank in concern (D) as the dependent variable.

Karl Pearson Correlation was measured using simple regression method in SPSS statistical package version 22 for hypothesis testing. Following hypothesis were tested,

### Hypothesis 1

H<sub>10</sub>: Green lending has no impact on green banking initiatives

H<sub>1a</sub>: Green lending has impact on green banking initiatives

### Hypothesis 2

H<sub>20</sub>: E-accounts has no impact on green banking initiatives

H<sub>2a</sub>: E-accounts has impact on green banking initiatives

### Hypothesis 3

H<sub>30</sub>: CDMs has no impact on green banking initiatives

H<sub>3a</sub>: CDMs has impact on green banking initiatives

### Hypothesis 4

H<sub>40</sub>: Internet banking has no impact on green banking initiatives

H<sub>4a</sub>: Internet banking has impact on green banking initiatives

### Hypothesis 5

H<sub>50</sub>: Electronic payment cards has no impact on green banking initiatives

H<sub>5a</sub>: Electronic payment cards has impact on green banking initiatives

## III. RESULTS AND DISCUSSION

Demographic analysis of the sample, analysis of data in order to reach conclusions on general perceptions of the customer towards digital products of the bank and its green initiatives and the regression analysis for hypothesis testing were carried out under data analysis. Demographic analysis found the sample has a good mix in terms of gender, income, education, occupation and age.

Results revealed 60.8% customers are having a clear idea on E-accounts introduced by the bank while customer awareness on E-statement and internet banking facility also lies high as 57.6% and 68.8% respectively. Customer awareness found to be significantly high on CDMs (76.8%). However the customer awareness on dedicated loan scheme of the bank on solar panel installation was found to be low as 44.8% and similarly the customer

awareness on SME loan scheme of the bank which offer interest concessions for upgrading and developing environmental performance of the businesses also found to be low as 48.8%.

Customer awareness on green banking initiatives of the bank found to be as below

**Table 1: Customer awareness of ABC banks concerns on green banking**

	Yes	Have heard but no clear idea	Not heard of
Percentage (%)	55.2	29.6	15.2

Results revealed 44% of the customers admit they got to know about green initiatives of the bank through television advertisements while 41.8% told it was through banking staff on their regular visits to the branch they got to know about the green initiatives of the bank. Special promotions however identified as the most ineffective means of promoting green banking initiatives of the bank as only 7% admitted it as their means of awareness on green initiatives of the bank. Girish (2016) has found 48% of customers are unaware of Green banking in Kerala banks.

**Table 2: Means of customer awareness about green banking initiatives by ABC bank**

	Yes	No
Bank staff (during visit to the branch)	41.8	58.2
Television advertisement	44.0	56.0
Print media advertisement	25.5	74.5
Special promotion	7.3	92.7
Social media	24.5	75.5
BOC website	14.5	85.5
Other	13.6	86.4

The results of the study partially contradicts with the findings of Bahl (2012) as his study has found event meetings, media and websites as the most effective means of making external sub sectors aware about green banking. Present study, studies by Bahl (2012) and Kumar and Anand (2015) have all found media as an effective method of promoting green banking.

**Table 3: Customer acceptance of digitized banking products offered by ABC**

	Use		Do not use	
	Frequency	Percentage (%)	Frequency	Percentage (%)
E-Accounts	44	35.2	81	64.8
CDM	81	64.8	44	35.2
Internet banking	74	59.2	51	40.8
E-statements	57	45.6	68	54.6
Electronic payment cards	104	83.2	21	16.8

The analysis also revealed 87.8% of the customers support the internal process modifications of the bank towards its journey to implementing green initiatives. Results of the present study agrees with Bahl (2012). His study has found mobile banking, net banking and accepting direct deposits as the most accepted and the preferred method of adopting green banking.

**Hypothesis testing**

Below table presents the summary results of the hypothesis testing

**Table 4: Summary of simple regression test**

Hypothesis	Regression equation	R value	Sig (2-tailed)	R-square - Linear
H1	D = 0.561(H1)+1.842	0.634**	0.000	0.402
H2	D = 0.617(H2)+1.624	0.691**	0.000	0.477
H3	D = 0.561(H3)+1.810	.656**	0.000	0.430
H4	D = 0.588(H4)+1.557	.686**	0.000	0.470
H5	D = 0.490(H5)+2.027	.561**	0.000	0.315

**Hypothesis 1:**

Hypothesis testing of the study concludes green lending has significant moderate positive relationship to the green banking initiatives at the said bank (R=0.634~0.600). P-value is 0.000 and is therefore under 0.05 significant level. Hence it accepts H1a= Green lending has impact on green banking initiatives at the said bank.

**Hypothesis 2:**

Hypothesis testing of the study found E-accounts has significant strong relationship to the green banking initiatives of the bank (R=0.690~0.700). P-value is 0.000

and is therefore under 0.05 significant level. Hence it accepts H2a= E-accounts has impact on green banking initiatives of the bank.

### Hypothesis 3:

Hypothesis testing of the study found CDMs found to have significant strong positive relationship to the green banking initiatives of the bank ( $R=0.656\sim 0.700$ ). P-value is 0.000 and is therefore under 0.05 significant level. Hence it accepts H3a= CDMs has impact on green banking initiatives of the bank.

### Hypothesis 4:

Hypothesis testing of the study found Internet banking has significant strong positive relationship to the green banking initiatives at the said bank ( $R=0.686\sim 0.700$ ). P-value is 0.000 and is therefore under 0.05 significant level. Hence it accepts H4a= Internet banking has impact on green banking initiatives of the bank.

### Hypothesis 5:

Hypothesis testing of the study found Electronic payment cards has significant moderate positive relationship to the green banking initiatives at the said bank ( $R=0.561\sim 0.600$ ). P-value is 0.000 and is therefore under 0.05 significant level. Therefore it accepts H5a= Electronic payment cards have impact on green banking initiatives of the bank.

## IV. CONCLUSION

The study concludes E-accounts, Internet banking and CDMs are all having a significant strong positive relationship to the green initiatives of the state bank in concern, while Green lending and Electronic Payment Cards concluded to be having significant moderate positive relationship to the green initiatives of the bank. E-account is concluded as the product which creates highest impact toward the green initiatives of the bank with a R square of 47.7%.

CDMs found to be the product with highest customer awareness while lending products implemented by the bank to promote green initiatives are concluded as having comparatively low customer awareness in relation to deposit products tested. Study concludes television advertisements and bank staff as the most effective means of making customer aware on its green initiatives. Customer awareness on green banking initiatives of the bank was at satisfactory level and high (85%) customer

support to the internal process modifications of the bank towards implementing green initiatives allows concluding the sustainability of green banking initiatives of the bank.

The findings of the study provides valuable insights to the management of the bank in implementing and promoting green banking initiatives across the bank. According to the result management of the bank needs to implement strategies to promote E-accounts among customers hence customer adoption to E-accounts are yet at significantly less although it found to be creating highest impact on green banking. Management of the bank also need to take necessary actions by implementing effective strategies to promote special loan schemes of the bank which has introduced to promote sustainable businesses hence customer awareness on green lending products found to be significantly less compared to customer awareness on green deposit products and services. As per the results of the study recommendations can be made to the management on most effective channels of customer awareness on green banking. Accordingly television advertisements and dissemination of product knowledge to customers though banking staff in normal course of business are recommended as the most effective channels for the above purpose. Most impotently results of the study assures the sustainability of the green banking concept and it therefore allows management of the bank to proceed ahead with its strategies to promote green banking with confidence.

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# DETERMINANTS THAT AFFECT THE SELECTION OF A LOGISTICS SERVICE PROVIDER IN THE MANUFACTURING INDUSTRY WITH REFERENCE TO SRILANKA

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**Abstract** - Nowadays Logistics outsourcing is an emerging trend in the manufacturing industry. Many manufacturing companies try to outsource their logistics activities to third parties to focus on their core competencies. Therefore, third party logistics industry is a strategic arm for today's companies especially in the manufacturing industry. Thus the purpose of this study was to analyze the factors which affect the selection of a logistics provider in the manufacturing industry. The objective of this research was to determine the factors which affect the selection of a logistics provider for the manufactures in Sri Lanka. The target sample of this research was manufacturing companies which outsource at least one logistics function to a logistics service provider. After a comprehensive literature review, a structured questionnaire was constructed with 25 variables. Likert scale with 5 responses was used to capture responses. The study collected primary data from 150 companies through a questionnaire survey. Among these companies, 123 valid responses were received (response rate of 82%). Convenient sampling was used as it was difficult to get responses from organizations. Executive and managerial level employees were taken into consideration in the survey. The SPSS software was used to analyze the data. Cronbach Alpha value of 0.905 was obtained and the KMO test resulted in a value of 0.82. Factor analysis was the main method of analysis. The Varimax rotated component

matrix was derived. This research identified seven main factors which affect selection of a logistics service provider by the manufacturers. Those are Assets related factor, Qualitative factor, Financial factor, Specialization factor, Risk and Expenses factor, Evaluation factor and Billing flexibility. Therefore logistics service providers for the manufacturing industry could be recommended to focus more on developing these highly influential factors to increase their competitiveness. Recommendations based on these factors are provided by this study.

**Keywords** - Manufacturing industry, Logistics service providers, Outsourcing, Purchasing of logistics services

## I. INTRODUCTION

When looking back into the history of logistics in the manufacturing industry, until the end of 19th century there was not much significant trends. In that time, according to the requirements from the market, manufacturers produced goods in their factories and shipped all around the world by means of road, rail, sea or air transportation. Although the logistics industry has a long history going back centuries, it was only in the late 19's that a trend called logistics outsourcing or 3PL (Third Party Logistics) came up. During this time, whether it was the improvements in e-commerce or emerging trend



of consumer markets around the world, the shippers had to face problems of finding ways to reduce cost and cater to the rapid demands of markets by partnering with 3PL providers. After a few decades of the commencement of this trend, today the success of the 3PL has become one of the most significant factors to influence the success of the entire supply chain especially in the manufacturing industry. Today it is very rare to find a manufacturer who has not outsourced at least one logistics function to a 3PL provider mainly because of high resource consumption, high logistics cost and risks of potential loss when those activities are performed in-house.

Presently the business environment has become highly competitive because of the new entrants to the market and globalization. With this the operations of organizations have expanded and it is difficult for organizations to manage and control all related functions successfully. Therefore the trend of outsourcing almost all the organizational functions which do not come under their core competencies has emerged. By doing this organizations can concentrate more on their core competencies and vital functions.

Therefore organizations have to select a logistics service provider to perform their logistics functions smoothly in day to day operations and most importantly, organisations have to decide the correct logistics service provider who can match with their requirements in daily operations as well as exceptional situations. This crucial decision can be influenced by several factors.

It is significant to identify the correct 3PL provider in order to ensure safe, timely and efficient transportation and storage of the goods manufactured. On the other hand, identifying the key factors that are considered by manufacturers becomes economically favorable for companies that provide 3PL services as they become aware of aspects and performance measurements that should be facilitated and improved in order to meet their customer requirements, to maintain trade popularity and sustainability in the competitive market. Thus, the research findings will help the service providers to provide higher excellence in customer service and manufacturers to decide on a suitable logistics partner.

Therefore the purpose of this study was to analyze the factors which affect the selection of a logistics provider in the manufacturing industry. The objective of this research was to determine the factors which affect the selection of a logistics provider by the manufactures in Sri Lanka.

## II. LITERATURE REVIEW

Outsourcing of logistics is defined as “multiple logistics services provided by a single vendor on a contractual basis” (Rozenes & Cohen, 2017). They offer “at least two services that are bundled and combined, with a single point of accountability using distinct information systems that are dedicated to and integral to the logistics process” (Bradley, 1994). However, at times it must be noted that outsourcing “may be narrow in scope” and limited to one type of service only (e.g., warehouse). According to Bradley (1994) there is no difference between outsourcing logistical functions and any other procurement process. It is stated that like a reliable supplier of materials and parts, contract logisticians should also provide a high level of customer satisfaction so that their clients can compete better.

In the traditional business environment logistics activities were handled as a supporting function to the core business. Activities such as warehousing, transportation, inventory management, distribution and material handling were given lower priority when compared with the other business functions. However, the need for developing sustainable competitive advantage, the growing emphasis on providing better customer service more effectively and efficiently and the strategic importance of focusing on core businesses and re-engineering gave rise to the evolution of outsourcing of logistics which is different from the handling of traditional logistics.

Outsourcing was a method to partner with service providers in order to handle specific business processes better, faster and at a lower operating cost (Polinini, 2001). The outsourcing function is growing about 20 percent to 25 percent per annum as it has become an alternative, which all major organizations must consider in order to maintain the competitiveness in their market (Davison, 2006).

The decision to outsource certain functions will depend on the organization’s plans, future objectives, product lines, expansion, acquisitions, etc. According to (Lynch, 2004) there are many logistics functions such as “outbound transportation, inbound transportation, warehousing, shipment consolidation/distribution, cross-docking, order fulfillment, freight bill auditing/payment, reverse logistics, product returns and repair, custom clearance and brokerage, consulting services, carrier selection, information technology, inventory management,

procurement of logistics, selected manufacturing activities, product marking, packaging and labeling that are outsourced.

For a manufacturer, although logistics is not a core business function, logistics can affect the entire success of the manufacturing process. Therefore when selecting a logistics service provider an organization has to consider about several main factors such as ability to provide logistics data after and during the shipment, business development, experience in operations, capabilities, competency, compatibility of third party's technology and the organizational requirements and technology, financial stability, improving standards, location, management structure, opportunities for development of long-term relationships, price, reliability, reputation, service quality, supplier certification, support services and systems, flexibility and capacity (Razzaque & Sheng, 1998). Further almost all the manufacturers are considering the factors such as service quality, rate level, service reliability, service speed and long term relationship (Hong, et al., 2004). Apart from these factors, others have considered factors such as responsiveness, assurance, empathy, tangibility and cost (Kong & Mayo, 1993). Further it is stated that reliability and customer relationship play an important role in the third party logistics provider selection process as they can improve the dependability of 3PL providers with satisfaction (Rajesh, et al., 2013).

Although cost is a major influence for the decision of outsourcing in the manufacturing industry, cost is not the first factor considered by most of the manufacturers when selecting a logistics service provider. Before the factor of cost, organizations are focusing more on technology, operations, finances and management skills.

The common factors most of the research have identified as the most vital factors which manufacturers may consider when selecting a logistics service provider are performance, cost and service. It is discussed in research that a logistics service provider who can deliver high-performance logistics functions, combined with thorough cost control capability and high-quality customer services will be given more priority when considering the selection of a 3PL provider by manufacturers.

All of these research have been conducted in different countries and therefore it is important to fill this gap in the Sri Lankan manufacturing industry too. Therefore this

research will analyze the factors which affect the selection of a logistics service provider with respect to the Sri Lankan manufacturing industry.

### III. METHODOLOGY

Selection of logistics service provider is considered as the dependent variable of this research and all the other factors considered for that selection by manufacturers are the independent variables. For the preparation of the questionnaire past related literatures were referred in order to identify the variables that affect the buying behavior of manufacturers when selecting a logistics service provider. Compatibility of the users, cost of service, quality of service, reputation of the company, long term relationship, performance measurement, willingness to use logistics man power, flexibility in billing and payment, quality of management, information sharing and mutual trust, operational performance, information technology capability, size and quality of fixed assets, experience in similar products, delivery performance, employee satisfaction level, financial performance, market share, geographical spread and range of services provided, risk management, freight price, financial stability, surge capacity of provider, understand clients supply chain needs, risk, bonus and reward sharing are the twenty five factors considered.

As the objective of this research was to determine the factors which affect the selection of a logistics provider by the manufactures in Sri Lanka, the target sample of this research was manufacturing companies which outsource at least one logistics function to a logistics service provider. After a comprehensive literature review, a structured questionnaire was constructed with the twenty five variables stated above. The Likert scale with five responses was used to capture responses. This study is based on primary data. The study collected primary data from one hundred and fifty companies through a questionnaire survey. Among these companies, one hundred and twenty three valid responses were received. Convenient sampling was used as it was difficult to get responses from organizations. Executive and managerial level employees were taken into consideration in the survey. The SPSS software was used to analyze the data. Cronbach Alpha value was obtained and the KMO test was conducted. Factor analysis was the main method of analysis used while descriptive statistics was also used. The Varimax rotated component matrix was derived.

### IV. ANALYSIS

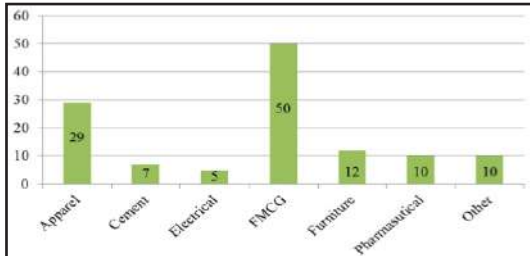


Figure 1: Types of organizations

As shown in Figure 1 different types of organisations were included in the research sample. Out of the data set of 123, 29 (23.6%) responses were collected from the apparel industry, 7 (5.7%) were collected from the cement industry, 5 (4.1%) were from the electrical industry, 50 (40.7%) entries were collected from the FMCG industry, 12 (9.8%) entries were from the furniture industry, 10 (8.1%) entries were collected from the pharmaceutical industry and 10 (8.1%) entries were collected from other industries which do not come under the above industries.

The software SPSS was used for the analysis of the study and the following were obtained.

#### Table 1: Reliability test

Reliability Statistics	
Cronbach's Alpha	N of Items
0.905	25

The value obtained for the reliability test as indicated in Table 1 was 0.905 which is higher than the acceptable value of 0.7 and this depicts the internal consistency of the data set.

#### Table 2: KMO and Bartlett's test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.82
Bartlett's Test of Sphericity	Approx. Chi-Square	1535.16
	df	300
	Sig.	0.000

As depicted in Table 2, the KMO value obtained was 0.82 which shows the sampling adequacy of this study.

Thereafter factor analysis was done. The extraction method used during the analysis was the Principal Component Analysis. As per the Eigenvalue rule seven factors affect the model and Table 3 depicts the values of Initial Eigenvalues, Extraction Sums of Squared Loadings and Rotation Sums of Squared Loadings. All of the factors which are greater than 'one', generated during this stage of the analysis defines the research model. There are seven factors of which the Initial Eigenvalues are greater than 'one' while the remaining of the twenty five factors are having less than 'one' Initial Eigenvalues values.

Table 3 depicts the variance represented by each factor. The highest amount of variance is represented by factor one which is around 31.29% and factor two represents about 12.97%. The next five factors explain 6.185%, 5.437%, 4.701%, 4.585% and 4.224% of the variance respectively. In total these seven factors represent 69.4% of the total variance.

Next the Varimax method was used to determine the effectiveness and verifications. Table 4 gives the results of the rotation method of varimax. Factors which have a value which is greater than 0.5 were considered as significant factors.

Therefore from the analysis the following functions can be defined:

**Factor 1** – f (Information Technology capability, Size and quality of fixed assets, Employee satisfaction, Market share)

Therefore it can be named as **Assets Related Factor**.

**Factor 2** – f (Compatibility of the users, Quality of service, Quality of management, Information sharing and mutual trust, Operational performance, Understand clients supply chain needs)

Therefore it can be named as **Qualitative Factor**.

**Factor 3** – f (Financial performance, Geographical spread and range of services provided, Financial stability, Surge capacity of provider, Risk, Bonus and Reward sharing)

Therefore it can be named as Financial Factor.

Factor 4 – f (Reputation of the company, Experience in similar products)

Therefore it can be named as Specialization Factor.

Factor 5 – f (Cost of service, Delivery performance, Risk management, Freight price)

Therefore it can be named as Risk and Expenses Factor.

Factor 6 – f (Long term relationship, Performance measurement, Willingness to use logistics man power)

Therefore it can be named as Evaluation Factor.

Factor 7 – f (Flexibility in billing and payment)  
Therefore it can be named as Billing Flexibility Factor.

**Table 3: Correlation analysis of asset related factors**

Correlations				
		Size	Position	Type
Qualitative Factors	Pearson Correlation	-0.171	.196*	0.122
	Sig. (2-tailed)	0.058	0.03	0.179
	N	123	123	123
*. Correlation is significant at the 0.05 level (2-tailed).				

According to the above results in the Table 5 only the significant value is area of the manufacturing goods (Type of goods produce) which lower than 0.05. So that, it concludes that factor 3 is only depended on area of the manufacturing goods (Type of goods produce). So the alternative hypothesis related to area of the manufacturing goods (Type of goods produce) is accepted where other hypothesis were rejected.

**Table 6: Correlation analysis of specialization factors**

Correlations				
		Size	Position	Type
Specialization Factors	Pearson Correlation	-0.103	-0.126	.372**
	Sig. (2-tailed)	0.259	0.166	0
	N	123	123	123
**. Correlation is significant at the 0.01 level (2-tailed).				

According to the above results in the Table 6 only the significant value of area of the manufacturing goods (Type of goods produce) is lower than 0.05. So that, it concludes that factor 4 is only depended on area of the manufacturing goods (Type of goods produce). So the alternative hypothesis related to area of the manufacturing goods (Type of goods produce) is accepted where other hypothesis were rejected.

**Table 7: Correlation analysis of risk and experience factors**

Correlations				
		Size	Position	Type
Risk and Experience Factors	Pearson Correlation	-0.145	0.047	0.086
	Sig. (2-tailed)	0.111	0.607	0.343
	N	123	123	123

According to the Table 7 significant level of all the demographic factors are higher than 0.05. So, none of the demographic factors are significant. Thus it proves that null hypothesis is accepted. So factor 5 is independent from demographic factors.

**Table 8: Correlation analysis of evaluation related factors**

Correlations				
		Size	Position	Type
Evaluation Factors	Pearson Correlation	-.229*	-0.053	.246**
	Sig. (2-tailed)	0.011	0.56	0.006
	N	123	123	123
*. Correlation is significant at the 0.05 level (2-tailed).				
**. Correlation is significant at the 0.01 level (2-tailed).				

According to the above results in the Table 8 significant values of size of the manufacturing company and area of the manufacturing goods (Type of goods produce) are lower than 0.05. So that, it concludes that factor 6 is only depended on size of the manufacturing company and area of the manufacturing goods (Type of goods produce). So the alternative hypothesis related to size of the company and areas of manufacturing are accepted where other hypothesis was rejected.

## V. DISCUSSION AND CONCLUSION

### A. Discussion

This study has identified seven important factors which explain 69.38% of the variance. These factors identified are Asset related factor, Qualitative factor, Financial factor, Specialization factor, Risk and Expenses factor, Evolution factor and Billing Flexibility factor. Manufacturers should pay more attention to these factors when selecting their logistics service provider. Logistics service providers too should concentrate on developing these aspects of their operation.

The parameters which come under the asset related factor are Information Technology capability, Size and quality of fixed assets, Employee satisfaction and Market share. The parameters which come under the qualitative factor are Compatibility of the users, Quality of service, Quality of management, Information sharing and mutual trust, Operational performance and Understand clients supply chain needs.

The parameters which come under the financial factor are Financial performance, Geographical spread and range of services provided, Financial stability, Surge capacity of provider, Risk, Bonus and Reward sharing. The parameters which come under the specialization factor are Reputation of the company and Experience in similar products.

The parameters which come under the risk and expenses factor are Cost of service, Delivery performance, Risk management and Freight price. The parameters which come under the evaluation factor are Long term relationship, Performance measurement and Willingness to use logistics man power. The parameter which comes under the billing flexibility factor is Flexibility in billing and payment.

### B. Conclusion

The purpose of this research was to analyze and identify factors which affect the selection of a logistics service provider by the manufacturing industry. The study has identified seven important factors which contribute towards such a decision. Therefore manufacturers should focus more on asset related factor, qualitative factor, financial factor, specialization factor, risk and expenses factor, evolution factors and billing flexibility factor when deciding on their logistics service providers as it will help them to improve their competitiveness and run their operation more smoothly. On the other hand logistics service providers also need to focus on improving these aspects of their operation as it is what the manufacturers or in other words their customers are interested in. Therefore it will help them to maintain a better relationship with their existing customers as well as help them to attract more customers.

The following can be recommended based on the study; logistics service providers should provide competitive rates for bulk volumes, implement online systems for real-time tracking of containers and locations, with user friendly apps fine-tuned for smart phones and other portable telecommunication devices and strive to develop strong and trust worthy long term relationships with their customers.

As further research it can be recommended to consider organizations stratified into categories as large scale, medium scale and small scale. Further research which focuses on data collection methods such as interviews may help gather more in depth information and issues.

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**Table 8: Correlation analysis of evaluation related factors**

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.821	31.29	31.3	7.82	31.29	31.29	3.274	13.1	13.098
2	3.242	12.97	44.3	3.24	12.97	44.25	2.965	11.9	24.958
3	1.546	6.185	50.4	1.55	6.185	50.44	2.957	11.8	36.788
4	1.359	5.437	55.9	1.36	5.437	55.87	2.367	9.47	46.254
5	1.175	4.701	60.6	1.18	4.701	60.57	2.041	8.16	54.416
6	1.146	4.585	65.2	1.15	4.585	65.16	2.029	8.12	62.533
7	1.056	4.224	69.4	1.06	4.224	69.38	1.713	6.85	69.384
8	0.886	3.546	72.9						
9	0.784	3.137	76.1						
10	0.68	2.719	78.8						
11	0.616	2.465	81.3						
12	0.554	2.217	83.5						
13	0.545	2.179	85.6						
14	0.506	2.025	87.7						
15	0.446	1.785	89.5						
16	0.441	1.765	91.2						
17	0.415	1.662	92.9						
18	0.312	1.249	94.1						
19	0.289	1.155	95.3						
20	0.255	1.022	96.3						
21	0.223	0.892	97.2						
22	0.205	0.821	98						
23	0.194	0.778	98.8						
24	0.177	0.708	99.5						
25	0.123	0.493	100						

Extraction Method: Principal Component Analysis

**Table 4: Rotated Component Matrix**

	Component						
	1	2	3	4	5	6	7
Compatibility	-0.211	<b>0.76</b>	0.138	-0.003	0.064	0.037	0.062
Cost	-0.152	0.512	-0.052	0.082	<b>0.528</b>	0.068	0.055
Quality	0.136	<b>0.754</b>	0.005	0.279	0.221	0.13	-0.111
Reputation	0.341	0.195	0.372	<b>0.584</b>	0.094	0.132	-0.343
Relationship	-0.005	0.251	0.071	0.392	0.215	<b>0.659</b>	-0.151
Performance measurement	0.127	0.218	0.142	0.521	0.061	<b>0.569</b>	0.126
Use of logistics man power	0.071	0.044	0.005	0.011	0.134	<b>0.85</b>	0.133
Flexibility of billing	0.093	0.143	0.174	0.091	0.232	0.144	<b>0.813</b>
Management quality	0.251	<b>0.476</b>	0.326	0.053	-0.148	0.45	0.295
Information sharing	0.394	<b>0.587</b>	-0.038	-0.104	0.101	0.343	0.183
Operational performance	0.238	<b>0.521</b>	-0.05	0.361	0.091	0.112	0.39
IT capability	<b>0.608</b>	-0.025	0.201	0.55	0.014	0.028	0.324
Size and quality of fixed assets	<b>0.621</b>	-0.032	0.136	0.464	0.259	0.107	0.023
Experience in similar	0.023	0.092	0.27	<b>0.729</b>	0.182	0.178	0.218
Delivery performance	0.028	0.15	0.051	0.242	<b>0.634</b>	0.052	0.385
Employee satisfaction	<b>0.833</b>	0.057	0.183	0.048	-0.033	0.079	-0.011
Financial performance	0.492	-0.032	<b>0.593</b>	0.255	0.02	-0.059	0.2
Market share	<b>0.704</b>	-0.06	0.451	0.007	0.09	0.061	0.016
Geographical spread	0.002	0.018	<b>0.63</b>	-0.023	0.417	0.186	0.017
Risk management	0.472	0.41	-0.007	-0.034	<b>0.532</b>	0.106	0.079
Freight price	0.238	0.046	0.25	0.133	<b>0.585</b>	0.203	-0.042
Financial stability	0.401	0.135	<b>0.674</b>	0.322	-0.004	0.024	0.009
Surge capacity	-0.001	0.274	<b>0.66</b>	0.234	0.041	-0.04	0.357
Understand client's needs	-0.079	<b>0.484</b>	0.118	0.013	0.474	0.04	0.328
Risk & bones sharing	0.364	-0.067	<b>0.738</b>	0.106	0.039	0.076	-0.029

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 15 iterations.

# ANALYSIS OF FACTORS AFFECTING THE EFFECTIVENESS OF INDIRECT PROCUREMENT PROCESS OF MANUFACTURING FIRMS

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**Abstract** - Procurement process can be considered as an activity of the initial stage of supply chain management, which will thus lead to attaining inputs which will significantly affect the output of the organization. When considering about the procurement function of manufacturing organizations, there are two categories as direct and indirect procurement. Indirect procurement is the procurement of components/material which will not be used as direct raw material for the production process. Although indirect procurement is not given attention as much as for direct procurement, indirect procurement is vital as it has the ability to hinder operations of an organization if not done properly. Therefore, this study is mainly focusing on the indirect procurement process in manufacturing organizations and about the factors which influence the indirect procurement process of manufacturing organizations. The purpose of the study was to analyze the factors which affect the effectiveness of indirect procurement process of manufacturing organizations while the main objective was to identify the factors which significantly affect the effectiveness of indirect procurement process. Primary data was collected through a questionnaire survey among 300 respondents within the procurement departments of different manufacturing companies. The respondents were selected from executive level and above. Convenient sampling method was used. 250 questionnaires were acceptable with a response rate of 83%. The Likert scale was used to obtain

the responses. The questionnaire consisted of 24 factors identified through the literature review. The collected data was analyzed using the SPSS software. The KMO test was done (value 0.919) and the Cronbach Alpha value 0.941 was obtained. Factor analysis was conducted and Varimax rotated component matrix was derived. 4 factors were extracted. According to the study the most influential factors for indirect procurement process are internal procurement procedures, operational characteristics of the procurement department, management of external factors and procedures with suppliers. Therefore, organizations should focus more on these factors to improve on the effectiveness of indirect procurement processes which will in return help them to have smoother and more productive operations.

**Keywords** - Indirect procurement, effectiveness, procurement process

## I. INTRODUCTION

The process of procurement of production materials and semi-finished products belongs to the process of supply chain logistics, which is essential to ensure the production schedule runs on time. It is necessary to ensure that production materials are supplied at the right time, at the right place at the right quality and in the right quantities.



Ensuring of purchases and continuous supply during the manufacturing process is an extremely challenging task, because often there are numerous types of material needed to utilize during the scheduled daily production tasks.

Procurement is not considered as a core function of a manufacturing organization but rather as a supporting function. The Porter's Value Chain template too depicts purchasing as a supporting process. But it is a main supporting service to all the departments and to all the processes. According to Porter's value chain too it can be used to gain competitive advantage over rival organizations (Kannegiesser, 2008). All purchasing needs of the organization have to be obtained via the procurement department and therefore procurement is a critical function to the organization's output. Indirect Procurement is defined as 'all the goods and services that are bought by the company to enable its activity. This entails a wide scope, including marketing related services (media agencies), Information Technology related services (hardware, software), Human Resources related services (recruitment, training), facilities management and office services (furniture, cleaning, telecoms, catering, printers), or utilities (electricity, gas, water) etcetera'.

Many of the organizations' internal and external factors which may be at times beyond the organizational control will affect the procurement process. In this study, the main purpose is to determine factors which affect to the indirect procurement process's effectiveness. By identifying these factors it will be helpful in defining methods and giving suggestions to improve the effectiveness of the indirect procurement process of a manufacturing firm. Therefore the objective of this study is to identify the main determinants which are affecting the effectiveness of the indirect procurement process of manufacturing organizations in Sri Lanka.

## II. LITERATURE REVIEW

Supply chain management can be defined as "planning, implementing and controlling the flow of information, materials and services from raw material and component suppliers to the manufacturing of the finished product for ultimate distribution to the end customer" (Ratnajeewa & Lokugamage, 2015). It is an integration of key business processes from end user through original suppliers that provides products, services, and information that add value for customers and other stakeholders. Also according to the global supply chain forum eight key

processes have been stated as to make up the core of supply chain management such as customer relationship management, customer service management, demand Management, order fulfilment, manufacturing flow management, procurement, product development and commercialization and returns (Keely, et al., 2001).

Procurement encompasses the whole process of acquiring property and/or services. It commences when a person/organization has identified a need and decided on its procurement requirement. Procurement continues through the processes of risk assessment, seeking and evaluating alternative solutions, contract award, delivery of and payment for the good and/or service and, where relevant, the ongoing management of a contract and consideration of options related to the contract. Also further explained, the procurement processes start from the initiation of the need by user department and its approval by the head of the department. Finally the ultimate disposal of the property at the end of its useful life also should be sometimes be overlooked by procurement (Waters, 2004). Further procurement can be defined as the business management function that ensures identification, sourcing, access and management of external resources that an organization needs or may need to fulfil its strategic objectives (Kidd, 2013). Also procurement is an important part of efficient management and supply of input and is critical for all levels of any institution. An effective procurement process ensures the availability of the right material in the right quantities, available at the right time, for the right purpose and at reasonable prices, and at recognizable standards of quality (Kiama, 2014).

Procurement can be segregated into two main categories as direct and indirect procurement. Manufacturing organizations acquire many types of goods and services which are used to fulfil different departments' requirements. As an example when considering about the raw materials procurement, it is done through the approved and specified procedures. Although raw material procurement is critical and vital to the organization, the indirect materials procurement is equally important for having a smooth organizational flow of processes. Except raw materials and components which go mainly into the manufacturing of products, all the goods and services which are needed to an organization can be categorized as indirect procurement.

Indirect procurement is mainly consisting of repairing equipment, office supplies or acquiring services. Without indirect procurement, organizations cannot process smoothly in an effective manner. Typically these indirect

procurement includes around 15-27% of an organization's total revenue (Loi,2013). Further procuring of goods for the manufacturing organizations can be denoted as raw materials, semi – finished products and components, finished products, maintenance, repair and operating items, production support items, services, capital equipment, transportation and third party purchasing. Indirect procurement can be further explained as procurement of goods or service that do not end up in the product or service delivered to a customer. Moreover factors such as having close working relationships with a limited number of suppliers, promoting open communication among supply-chain partners and developing long-term strategic relationship orientation to achieve mutual gains will help to achieve better output of the procurement process. Whilst having an open communication among the supply chain partners, the collaboration between procurement and users increase and it helps to get a better output of the procurement process. Also by maintaining long term relationships, supplier flexibility and loyalty can be increased whilst it will lead to gain a smooth procurement process. It is stated that the financial performance of a buying organization has a clear linkage with the procurement process.



Figure 1: Indirect procurement process

Figure 1 depicts the indirect procurement process that is commonly followed by organizations. Depending on the type of indirect material/service purchased there could be variations in this basic process. When looking into this process, there are some of vital factors which have to be considered when selecting optimal suppliers. These factors can be taken such as cost, technical capability, quality assessment, organizational profile, service levels, supplier profile and also risk factors. The ability to manage these factors and select the optimal supplier is critical in the procurement process. Further with the current technological trend, automating of the transactional

procurement process will help to improve the procurement performance. Also factors such as availability of key organizational resources, participation and involvement of selected suppliers when required, higher level of internal and external decision making authority, effective team leadership and higher levels of effort put forth on team assignments can be considered as critical success factors on the procurement process, thus will contribute to better output of procurement performance (Trent, 2004).

### III. METHODOLOGY

The effectiveness of the indirect procurement process is considered as the dependent variable of this study. Internal procurement process factors, procurement department characteristics, management of external factors and characteristics of supplier dealing are the main independent variables considered. The study was based on primary data collection. To obtain the primary data, a questionnaire was designed consisting of the factors obtained through an extensive literature review. It was identified that twenty four factors may influence the indirect procurement process. Thereafter a questionnaire survey was conducted. The questionnaire was distributed among the procurement departments in manufacturing organizations. The Likert scale with five options was used to capture the responses in the questionnaire. 300 respondents within the procurement departments of different manufacturing companies were considered as the sample and the respondents were selected from executive level and above. The sample size was decided based on the samples of the previous studies which were between 200 and 300. A non-probability sampling method; the convenient sampling method was used as it was difficult to get responses from certain organizations. 250 questionnaires were acceptable with a response rate of 83%. The conceptual framework depicted in Figure 2 was developed based on previous literature and factors identified.

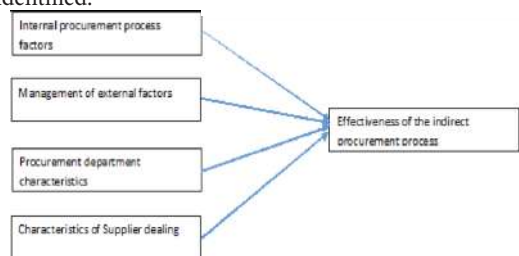


Figure 2: Conceptual Framework

During the analysis, the Kaiser–Meyer–Olkin (KMO) test was used to test the sampling adequacy of the study. The reliability of the sample was analysed through Cronbach’s Alpha value which evaluates the internal consistency within the variables of the study. Descriptive statistics and factor analysis were used as the main data analysis methods. SPSS was the software used for the data analysis.

#### IV. RESULTS

The collected data was entered into SPSS 22.0 which can be identified as a statistical software tool.

**Table 1: Test of Reliability using the Cronbach Alpha value**

Cronbach’s Alpha	Cronbach’s Alpha Based on Standardized Items	N of Items
.941	.941	24

**Table 2: KMO test value**

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	.919
Bartlett’s Test of Sphericity Approx. Chi-Square	2.796E3
Df	276
Sig.	.000

As in Table 2 the KMO value obtained is 0.919 which is greater than the acceptable value of 0.5, therefore this ensures the sampling adequacy of the study. The Cronbach’s Alpha value is 0.941, as in Table 1, which is greater than the acceptable value of 0.7, therefore the internal consistency is depicted.

There are two types of factor analysis available which are exploratory factor analysis and confirmatory factor analysis. In this study exploratory factor analysis has been carried out. The extraction method used is the Principal Component Analysis. As per the Eigenvalue rule four factors affect the model and Table 3 depicts the values of

Initial Eigenvalues, Extraction Sums of Squared Loadings and Rotation Sums of Squared Loadings. All the factors which are greater than 1, generated by SPSS defines the research model. There are four factors of which the Initial Eigenvalues are greater than 1 while rest of the other twenty four factors are having less than 1 Initial Eigenvalues values.

Varimax method is used to determine the effectiveness and verifications. Results of the rotation method of varimax is shown in Table 4. Factors which are having a greater than 0.5 value are considered as significant factors.

As per the given Table 3, the highest amount of variance is represented by factor one which is about 42.97% and respectively other 3 factors represents 6.588%, 4.814% and 4.353%. Altogether these four factors represent 58.73% of the total variance.

From the analysis the following functions can be defined: Factor 1 = f (Access to data for the internal parties, Close relationships with a limited number of suppliers, Promote open communication among supply chain partners, The skills and competencies of the procurement people, Better corporation and communication with user departments and other stakeholders, Organizational wide policies and procedures, Supplier site visits, Due Diligence and contract negotiation, Maintain Adequate and appropriate records throughout the procurement process, Carry out market research to identify potential suppliers ). Moreover Factor 1 can be identified as Internal Procurement procedures.

Factor 2 = f (Budget constraint for procure of goods, Consider on complaints and compliments, Magnitude of the work assigned to procurement department, Continuously improve and re-evaluate the purchasing activities, Fixed vendors to supply a particular product or service that is routinely purchased, Conduct a capability review of the existing supply base, Consider about the whole life costing once purchasing goods Continuously improve and re-evaluate the purchasing activities- purchase price, maintenance cost, operating cost ,disposal cost, Establish and identify potential risk to the business) Moreover Factor 2 can be identified as Operational characteristics of the procurement department.

Factor 3 = f (Access to data for external parties, Environmental concerns for acquire goods and services, Moving towards the electronic purchasing tools;

e-procurement, purchase-to-pay, e sourcing)

Moreover factor 3 can be defined as Management of external factors.

Factor 4 = f (Assess shortlisted suppliers, Identify the suppliers who are vital to specified business units, Product Testing)

Moreover factor 4 can be defined as Procedures with suppliers.

## V. DISCUSSION AND CONCLUSION

### A. Discussion

According to the results obtained from the study there are four main factors which influence the effectiveness of the indirect procurement process in the manufacturing industry in Sri Lanka. The total variance explained by these four factors is 58.73%. The factors are Internal Procurement procedures, Operational characteristics of the procurement department, Management of external factors and Procedures with suppliers. This depicts that manufacturing organizations should focus more on these factors to improve the effectiveness of their indirect procurement. The improvement of the indirect procurement process will help to smoothen the production process and other operational activities of an organization.

The parameters which affect the factor of Internal Procurement procedures are Access to data for the internal parties, Close relationships with a limited number of suppliers, Promote open communication among supply chain partners, The skills and competencies of the procurement people, Better corporation and communication with user departments and other stakeholders, Organizational wide policies and procedures, Supplier site visits, Due Diligence and contract negotiation, Maintain Adequate and appropriate records throughout the procurement process and Carry out market research to identify potential suppliers.

The parameters which affect the factor of Operational characteristics of the procurement department are Budget constraint for procure of goods, Consider on complaints and compliments, Magnitude of the work assigned to procurement department, Continuously improve and re-evaluate the purchasing activities, Fixed vendors to supply a particular product or service that is routinely

purchased, Conduct a capability review of the existing supply base, Consider about the whole life costing once purchasing goods Continuously improve and re-evaluate the purchasing activities- purchase price, maintenance cost, operating cost ,disposal cost, Establish and identify potential risk to the business.

The parameters which affect the factor of Management of external factors are Access to data for external parties, Environmental concerns for acquire goods and services, Moving towards the electronic purchasing tools; e-procurement, purchase-to-pay, e sourcing.

The parameters which affect the factor of Procedures with suppliers are Assess shortlisted suppliers, Identify the suppliers who are vital to specified business units and Product Testing.

### B. Conclusion

This research has studied about the factors which affect the effectiveness of the indirect procurement process in the manufacturing organizations in Sri Lanka. The factor analysis method has been used in this study to identify the main factors and this research has identified four main factors as Internal Procurement procedures, Operational characteristics of the procurement department, Management of external factors and Procedures with suppliers. Organizations need to focus equal attention to indirect procurement as the attention given to direct procurement as it is an area which has potential to disrupt the smooth functioning of the organization.

As further research, the manufacturing industry can be categorized according to their production areas and the relevant factors for the effectiveness of the indirect procurement process can be identified. Additionally government procurement can be studied as this research focused only on private organizations.

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**Table 3: Total Variance Explained**

Component	Initial Eigenvalues		Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings			
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	10.314	42.976	42.976	10.31	42.976	42.976	4.89	20.403	20.403
2	1.581	6.588	49.564	1.581	6.588	49.564	4.44	18.513	38.916
3	1.155	4.814	54.378	1.155	4.814	54.378	2.54	10.600	49.515
4	1.045	4.353	58.731	1.045	4.353	58.731	2.21	9.216	58.731
5	.925	3.854	62.585						
6	.865	3.606	66.191						
7	.777	3.239	69.430						
8	.761	3.172	72.601						
9	.705	2.936	75.537						
10	.675	2.814	78.352						
11	.634	2.640	80.991						
12	.596	2.485	83.476						
13	.501	2.087	85.563						
14	.448	1.867	87.430						
15	.427	1.778	89.208						
16	.404	1.682	90.890						
17	.361	1.504	92.394						
18	.353	1.470	93.864						
19	.328	1.365	95.229						
20	.277	1.154	96.383						
21	.260	1.084	97.467						
22	.238	.993	98.460						
23	.206	.857	99.317						
24	.164	.683	100.000						

Extraction Method: Principal Component Analysis.

**Table 4: Rotated Component Matrixa**

	Component			
	1	2	3	4
[Allowing access to data for the internal parties.]	.589	.243	.148	.155
[Allowing access to data for external parties]	.345	.313	.396	.242
[Manage close working relationship with a limited number of suppliers]	.549	.467	-.144	.072
[Promote open communication among supply chain partners.]	.766	.154	.082	.282
[Budget constraint for procure of goods ]	.326	.412	.290	.218
[The skills and competencies of the procurement people ]	.562	.372	.292	-.003
[Consider on complaints and compliments.]	.374	.537	.281	.145
[Better corporation and communication with user departments and other stakeholders]	.684	.286	.035	.175
[Magnitude of the works assigned in to procurement department.]	.255	.532	.290	.033
[Organizational wide policies and procedures such as SOP's ]	.520	.501	.169	.215
[Environmental concerns for acquire goods and services.]	-.040	.296	.726	.243
[Assess shortlisted suppliers]	.226	.011	.205	.728
[Supplier site visits]	.609	.111	.537	.066
[Due Diligence and contract negotiation]	.651	.338	.291	.052
[Maintain Adequate and appropriate records throughout the procurement process]	.649	.424	.220	.086
[Continuously improve and re-evaluate the purchasing activities.]	.294	.750	.034	.210
[keep vendors to supply a particular product or service that is routinely purchased]	.324	.649	.251	-.105
[Conduct a capability review of the existing supply base]	.333	.573	-.065	.428
[Carry out market research to identify potential suppliers]	.486	.374	.219	.302
[Identify the suppliers who are vital to specified business units]	.376	.406	.012	.559
[Moving towards the electronic purchasing tools; e-procurement, purchase-to-pay, e sourcing]	.280	.079	.752	.233
[Consider about the whole life costing once purchasing goods (purchase price, maintenance cost, operating cost ,disposal cost )]	.144	.668	.205	.280
[Establish and identify potential risk to the business ]	.360	.582	.380	.103
[Product Testing]	-.008	.176	.341	.714

Extraction Method: Principal Component Analysis.  
 Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 9 iterations.

# DETERMINING THE STATISTICAL PROCESS CONTROL LIMITS FOR UNCERTIFIED SRI LANKA STANDARD (SLS) BOXES OF MATCHES IN SRI LANKAN MARKET.

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**Abstract** - Quality control limits through Statistical quality control charts are used to control the quality of the process in product manufacturing. It can be used to determine whether the manufacturing process is operating according to the desired quality standards. Manufacturing boxes of matches should be in appropriate quality as it is considered the safety consuming item. This paper addresses the main objective of determining the statistical quality control limits for uncertified Sri Lanka Standards (SLS), boxes of matches manufactures in Sri Lanka. Sub research objective is “to determine whether SLS Uncertified Boxes of matches are Really safety related to its production process.” 1135 sample units of match sticks were used for the study using 25 samples for the study. Primary data were gathered using direct observation method from uncertified Sri Lanka Standards box of matches manufacturers regarding the considered quality characteristics in both variables and attributes in product. Eight quality dimensions such as the number of matches in a box, ignition and burning, afterglow, length of splint and match head, bending strength, were the considered quality characteristic of the boxes of matches. These quality characteristics were taken from SLS recommendations. Statistical Quality control equations, Statistical quality charts were used to

analyse the data. Lower control and upper control levels of the characteristic of the SLS uncertified match boxes are as follows. Length of Splint 30.7 mm -34.8mm, length of the head 3.3mm -3.5mm, Burning time 13.8sec – 17.8 sec, Bending strength 35.1sec-40.7 sec, Afterglow 1.46 sec-2sec, safety 0 -12.6, adherence 0-4.89 , No of match sticks in the box 44-46 sticks.

Generated quality control limits prevailed within SLS requirements except the quality dimensions, the Length of Splint and the Burning time. They highlight that these boxes of matches which do not have SLS are unsafe due to the uncontrolled production process based on SLS. Thus, the Sri Lankan manufacturers should draw their attention to produce full quality productions with a high priority to safety.

**Keywords** - Quality Control limits, boxes of matches, Quality Control charts.

## I. INTRODUCTION

Sri Lanka makes an attempt to remain and enhance the position in the world market while marching parally with the changes in global economy factors. Therefore, to compete and to win the competitions in global market and local market, Sri Lankan industries are drawing attention towards for innovative and cost reduction strategies and making big efforts to overcome the difficulties of them. According to the annual report of Central Bank of Sri Lanka, highlights that the industry sector in Sri Lanka is achieving less presentation in G.D.P Around less than 32% in 2015 and this mount as well as components in industry sector shows the positive trend in changes in GDP compared to previous years. Therefore, it is need of the time to draw attention towards the marketing procedures as well as a quality of the Sri Lankan industry products due to the Quality Of the product is considered as a primary indicator of organizational performance and key parameter in order to measure the performance of the product and services. Many researchers identified that Quality of the products resulted the in gaining sustainable competitive advantages (Gronroos 1998). The key of the quality can ability to exceed the expectations of the customers by providing them a required products or services which have low cost on time and very time. (Chinyemba 2008, Wachs 2011). There for its needed to consider about the quality of the products and the procedure of quality control in an organization to meet the customer expectation in developing industry sector in Sri Lanka.

Quality control and Quality Assurance Should be properly maintained in aim of having a proper production system stating from obtaining appropriate materials to deliver a quality product to the customers. Quality control procedures ensure the quality of the specific sample or batch which include the analysis of reference materials (ISO 8402 Quality Vocabulary). Statistical process Control methods are used in manufacturing system in aim of upgrading the system to improve on quality and cost effective. It emphasizes on early detection and prevention of a problem and bring distinct advantages over quality methods such as inspection of end product (Mason 2017). Key tools in Statistical Process control are control charts, continues improvement and design experiments (Franco-Santo et al 2017). Variations of the production process which lead to the poor quality can be detected and corrected. This provides real time analysis to make a controllable baseline and improve process capabilities

and focus on the areas which should be needed in a manufacturing process (Tan 2002). Thus, this paper is focus on the determining Statistical Quality Control for the non-Sri Lanka Standards certified matches in boxes manufacture in Sri Lankan to analyse the quality in the process in safety purpose.

## II. LITERATURE REVIEW

Statistical Process Control is a procedure of statistical method applying for control and monitoring the manufacturing process in aim of producing the quality products through ensuring whether that the production process is out of control. The evaluation of quality control is begun with the inspection (Dooley 2000). Detection of unconformity products and causes arguments regarding how these methods fail to facilitate economical quality procedures, are considered as the basis of inspection mechanism in production. All these considered due to the detection of products defects and variation in production line being considered too late to be solved (Deming 1986). In aim of prevention of problems, a better tool which generate advantages over inspection should be needed.

The systematic mechanism of Statistical quality control is considered as Statistical Process Control. This systematic process control tools in Quality Control technique highlights the excellence in Business performance in different industry spheres (Mann et al 1999). There are seven Statistical Quality Control tools such as Check sheet, Histogram, Pareto Charts, Cause and effect Diagram, Scatter diagram, Control Charts. Among these Statistical Quality Control, Control Charts are the most common tools for determining whether a process is under control or not in manufacturing process. Therefore, in this study Control Charts under Statistical Quality Control are used to determine whether the process of manufacturing Sri Lanka Standards (SLS) uncertified matches in a box are under control or not.

Boxes of matches are usual consumption item in Sri Lankan life style. Boxes of matches are consumption in Sri Lanka for various reasons such as fire for source of energy for cooking in rural areas, complements good for a cigarette etc. The significant contribution made by these boxes of matches are identified as important element in goods in calculating Sri Lankan Colombo Consumer Price Index. According to the Sri Lankan Socio- Economics Data 2016 highlights that 78.5% represented the Firewood



as a source of energy for cooking. Gas represented 18.5 % and Kerosene represented 1.9 % from total source of energy. Uva province recorded 95.2% as majority of people use firewood as a source of energy for cooking. North Central Provinces recorded nearly 94.8% of firewood usage and North Western province recorded nearly 92.5% of firewood usage as a source of energy for cooking. It highlights without considering the provinces people consuming boxes of matches to fire the firewood rather than other energy sources. When we look at total expenditure of a household in year 2015 people expenditure nearly 6.8% for fuel and light from their monthly salary. Eastern Proving household recorded the highest rate of 12.3 for fuel and light from their monthly salary (Sri Lankan Socio- Economics Data 2016).

Thus, above central bank reports highlights that the consumption behaviour of the people regarding the energy sources and expenditure patterns of the Sri Lankans which recorded significant value leads to the consumption of Boxes of matches as essential element in daily household products. This highlights that the quality of the boxes of matches should be drawn attention in order to ensure the safety of the consumers. When we look at the quality consideration of boxes of matches in India, Indian Government has revised their standard of Indian Standard Specification for safety matches in boxes as IS 2653:2004 replacing IS 2653: 1993.

According to the Central Market Department 11 in India 2004 highlights that the requirements of quality control in boxes of matches should be in the form of Contents, match of boxes, envelopment, easy of opening, Match splints, Unserviceable sticks. In Sri Lanka, there is a standard introduced and issued by the Sri Lanka Standard Institute for the manufacture of boxes of matches under SLS (Sri Lanka Standard) 11, "Safety Matches in Boxes". It is imposed to follow in safety procedures under SLS 11 to manufacture, distribute, transport, store and sell or display for sale of safety matches in boxes under the consumer Affairs Authority Act No 09 of 2003. (Extraordinary Gazette 2012). But in Sri Lankan market we can find boxes of matches under company names which do not certified SLS for the safety matches of boxes. Therefore, this paper Address the quality control limits in control charts to ensure the process quality in SLS uncertified Boxes of matches in Sri Lankan market.

### III. PROBLEM STATEMENT

#### A. Research questions

Main research question is "What are the Statistical quality control limits for the uncertified Sri Lanka Standards (SLS), boxes of matches in Sri Lankan market?". And sub research question is "Are SLS Uncertified Boxes of matches manufactured in Sri Lanka are Really safety to consume?"

#### B. Main objective

Based on research questions following research objectives are derived. Main research Objective of the study is "To determine the Statistical quality control limits for uncertified Sri Lanka Standards (SLS), boxes of matches in Sri Lankan market". Sub research objective is "To determine whether SLS Uncertified Box of matches are Really safety to consume."

### IV. METHODOLOGY

This is a quantitative research in nature. Primary data are collected for the study. Basically, sample is considered by number of match sticks. 1135 sample units of match sticks are used for the study. These sample units are drawn under 25 samples and each sample is consisted with 3 boxes of matches. 1135 match sticks are taken from 75 boxes. For Analysis purpose number of box of matches also considered for quality dimension. Sample size is decided by 25% from a hourly production. Direct observations activities are carried out to get generated the quality characteristics under 08 quality dimensions. These dimensions are considered based on Sri Lanka Standards (SLS) and other quality standard related to manufacture of boxes of matches. The eight (08) quality dimensions considered for the study related to manufacturing process of boxes of matches are highlighted in this table no 02

**Table 01. Considered Quality dimensions**

Quality dimension no	Quality Dimension	Feature
1	Length of Splint (the match stick) with head	Total length of the match stick
2	length of the head	Length of chemical head
3	Burning time	Burning up to the half of the match length and consider the time
4	Bending strength.	The time to bear 300g weight by each stick
5	After glow	After burning first quarter of the stick time taken to extinguish.
6	Safety	Each stick hope to strike the match against a suitable surface (sand paper)
7.	adherence	Check whether the stick can be separable from the match stick
8	No of match sticks in the box.	Check the number of sticks in the box.

Inclusive criteria of selecting samples are 1. Only wax boxes of matches are considered. 2. Non-Sri Lanka Standards (SLS) certified boxes of matches are considered. Exclusive criterias are non-wax manufacture boxes of matches are not considered. Statistical Quality control equations and process control charts for variables and attributes are used to analyses the data. X bar charts and Range charts, np charts are used for the analysis purpose.

## V. ANALYSIS

To analyses the Quality dimension number 1,2,3,4,5,8 in table no 01, Statistical quality control charts such as x bar charts and Range charts are used under variable control charts. To analyses the Quality Dimension Number 6,7 Statistical quality control charts such as np charts are used. x bar charts are used to determine the variation between the samples and R charts used to determine the variation inside the sample. Control line figures calculations relevant to the x bar charts are shown in table no 03. and control lines figure calculations related to range charts are highlights in table no 04

**Table no 02-Control level calculations for x bar charts**

Quality dimension no	Upper control level	Central level	Lower control level
1	$\bar{x} + A_2 \times \bar{R}$ 32.76+(1.023*2)= 34.8	$\bar{x}$ =32.76	$\bar{x} - A_2 \times \bar{R}$ 32.76-(1.023*2)= 30.7
2	$\bar{x} + A_2 \times \bar{R}$ 32.76+(1.023*2)=3.5	$\bar{x}$ =3.4	$\bar{x} - A_2 \times \bar{R}$ 32.76-(1.023*2)=3.3
3	$\bar{x} + A_2 \times \bar{R}$ 15.8+(1.023*1.96)= 17.8	$\bar{x}$ =15.8	$\bar{x} - A_2 \times \bar{R}$ 15.8-(1.023*1.96)=13.8
4	$\bar{x} + A_2 \times \bar{R}$ 37.9+(1.023*2.72)=4 0.7	$\bar{x}$ = 37.9	$\bar{x} - A_2 \times \bar{R}$ 37.9-(1.023*2.72)=35.1
5	$\bar{x} + A_2 \times \bar{R}$ 1.68+(1.023*0.212)= 2	$\bar{x}$ =1.68	$\bar{x} - A_2 \times \bar{R}$ 1.68-(1.023*0.212)=1.46
6	$n\bar{p} +$ $3 \times \sqrt{n\bar{p}(1-\bar{p})}$ 12.6	$n\bar{p}$ =5.7	$n\bar{p} -$ $3 \times \sqrt{n\bar{p}(1-\bar{p})}$ 0
7.	$n\bar{p} +$ $3 \times \sqrt{n\bar{p}(1-\bar{p})}$ 1.38+3.51=4.89	$n\bar{p}$ =1.38	$n\bar{p} -$ $3 \times \sqrt{n\bar{p}(1-\bar{p})}$ 1.38-3.51=0
8	$\bar{x} + A_2 \times \bar{R}$ 45.32+(1.023*1.08)= 46.4	$\bar{x}$ =45.32	$\bar{x} - A_2 \times \bar{R}$ 45.32-(1.023*1.08)=44.2

**Table no 03-control level calculations for Range charts**

Quality dimension no (according to table no 01)	Upper control level	Central level	Lower control level
1	$D_4 \bar{R} = 2.574 * 2 = 5.1$	$\bar{R} = 2$	$D_3 \bar{R} = 0 * 2 = 0$
2	$D_4 \bar{R} =$ $(2.574 * 0.144) =$ $0.37$	$\bar{R}$ $= 0.144$	$D_3 \bar{R} = 0 * 0.144 = 0$
3	$D_4 \bar{R} = 2.574 * 1.96 = 5$	$\bar{R} = 1.96$	$D_3 \bar{R} = 0 * 1.96 = 0$
4	$D_4 \bar{R} = 2.574 * 2.72 = 7$	$\bar{R} = 2.7$	$D_3 \bar{R} = 0 * 2.72 = 0$
5	$D_4 \bar{R} =$ $2.574 * 0.2 = 0.55$	$\bar{R} = 0.2$	$D_3 \bar{R} = 0 * 0.2 = 0$
8	$D_4 \bar{R} = 2.574 * 1.08$	$\bar{R} = 1.08$	$D_3 \bar{R} = 0 * 1.08 = 0$

1) Length of Splint (the match stick) with head

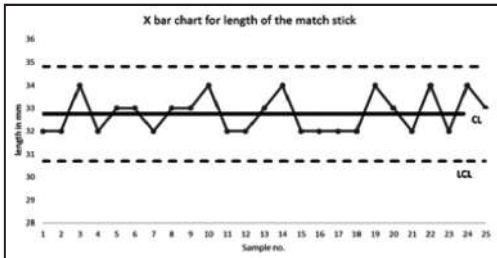


Figure 01. x bar chart for length of splint

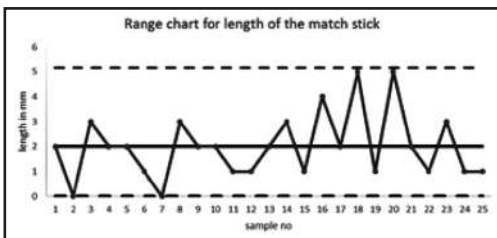


Figure 02. Range chart for length of splint

All sample points are prevailed between the control lines in both xbar chart and Range chart. Therefore, process of Length of Splint (the match stick) with head is under control.

2).Length of the head:

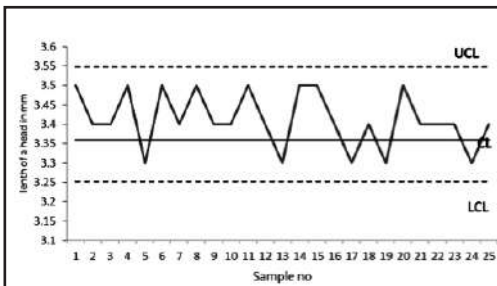


Figure 03. x bar chart for length of the head.

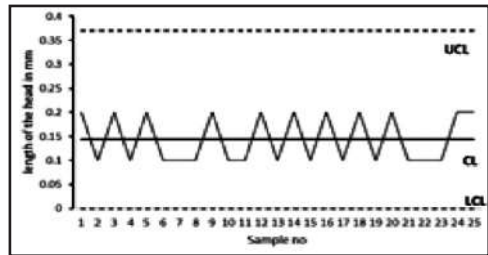


Figure 04. Range chart for length of the head.

All sample points are prevailed between the control lines in both xbar chart and Range chart. Therefore, process of manufacturing length of the head is under control

3) Burning time

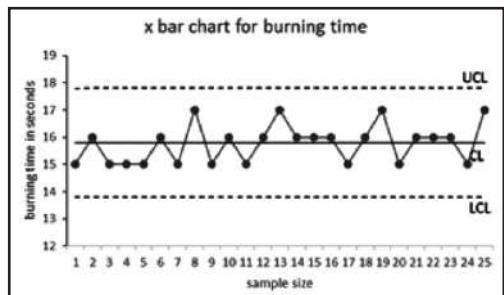


Figure 05. x bar chart for burning time.

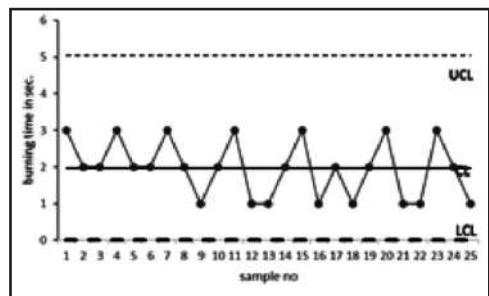


Figure 06. Range chart for burning time.

All sample points are prevailed between the control lines in both xbar chart and Range chart. Therefore, process of manufacturing matches with good burning time is under control

4.) Bending strength.

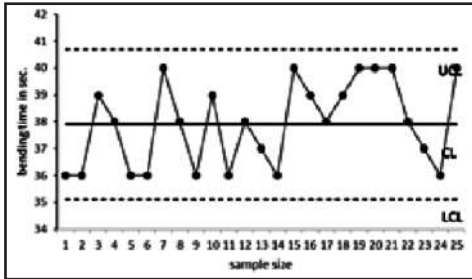


Figure 07. x bar chart for Bending strength.

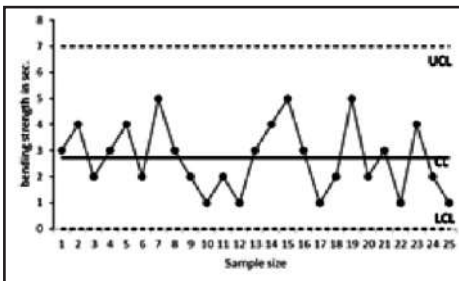


Figure 08. Range chart for Bending strength.

sample points are prevailed between the control lines in both xbar chart and Range chart. Therefore, process of manufacturing matches with good bending strength is under control.

5). After glow

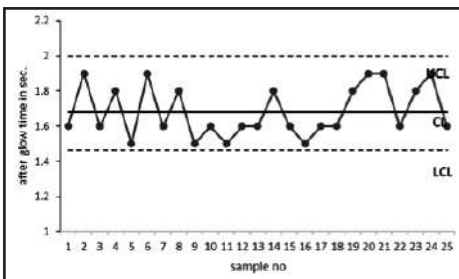


Figure 09 x bar chart for After glow

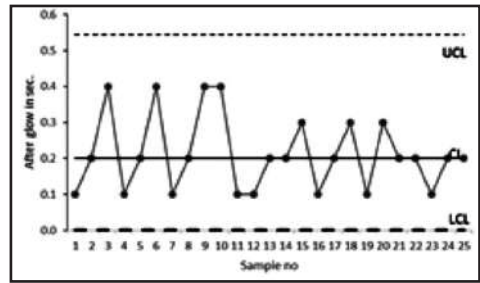


Figure 10 Range chart for After glow

All sample points are prevailed between the control lines in both xbar chart and Range chart. Therefore, process of manufacturing matches with good afterglow is under control

6). Safety

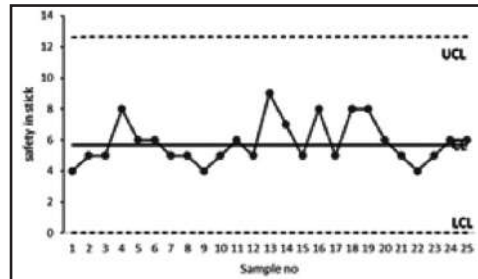


Figure 11 np chart for safety

All sample points are prevailed between the control lines in np chart. Therefore, process of manufacturing matches with good Ignite is under control.

7). Adherence

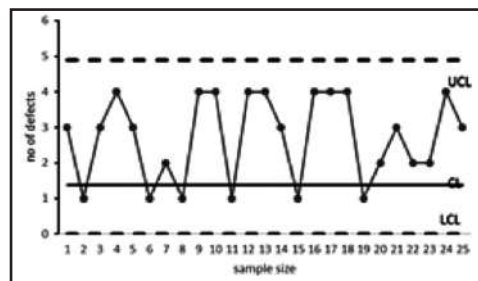


Figure 12 np chart for Adherence

All sample points are prevailed between the control lines in np chart. Therefore, process of manufacturing matches with Adherence is under control.

8). No of match sticks in the box.

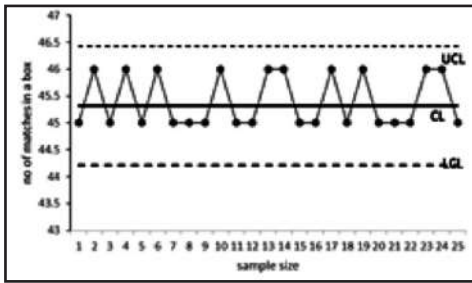


Figure 13 x bar for No of match sticks in the box.

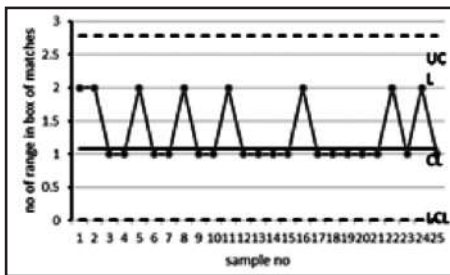


Figure 13 x bar for No of match sticks in the box

All sample points are prevailed between the control lines in both xbar chart and Range chart. Therefore, process of manufacturing matches with appropriate No of match sticks in the box under control

VI. CONCLUSION

According to the analysis data quality control limits for the selected quality dimensions for the uncertified SLS boxes of matches are identified as an objective of the study in the Table no 04.

Table no 04.- quality control limits compared with SLS

Quality Dimension	quality control limits for SLS Uncertified boxes of matches	SLS Limit
Length of Splint (the match stick) with head	30.7mm -34.8mm	32-35 mm
length of the head	3.3mm-3.5mm	3.5mm >
Burning time	13.8- 17.8	15s -18 s
Bending strength.	35.1- 40.7 sec.	30s -40s
After glow	1.46s-2s	3sc<
Safety	10>	10>
adherence	unremovable	unremovable
No of match sticks in the box.	appropriate	appropriate

According to the table no 10 it is revealed that generated quality control limits are prevail within SLS except the quality dimensions Length of Splint and Burning time. That highlights that these boxes of matches which do not have SLS are unsafety due to the uncontrol production process based on SLS.

RECOMMENDATIONS.

The manufactures those who are not having SLS to produce boxes of matches should have ability to make changes and open a path to obtained the SLS to create win-win situation for the both parties.

ACKNOWLEDGEMENT

Thank you all those who extended their helping hand when we were engaging in this study especially to the “Shakthi” box of matches manufactures in Kandy Providing us all equipments and tools and their tremendous support.

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# THE IMPACT OF MICRO FINANCIAL SUPPORT ON DEVELOPMENT OF SMALL AND MEDIUM SCALE ENTERPRISES (SMEs)

(With special reference to Anamaduwa Divisional Secretariat in Puttlam District)

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**Abstract** - SMEs play an important role in any economy through generation of employment, contribute to the growth of GDP, embark on innovation and simulating of other economic activities. Over the years Micro Finance Institutions play a vital role in fulfilling the financial needs of SME holders and create a platform for SMEs growth. The growth in SMEs should be encouraged and supported to bring about favorable economic growth and development, alleviate poverty and improve the standards of living. Therefore, the main objective of the study was to examine the impact of micro financial support on growth and development of SMEs. 100 SME holders in Anamaduwa Divisional Secretariat Division in Puttlam District were used as the sample using the Morgan approach of sample selection through the purposive sampling technique, using a structured questionnaire. Multiple regression model revealed that, financing of SMEs (credit facilities), development of management skills and marketing facilitation cause to increase the growth and development of SMEs and the development of management skills could be identified as the most crucial factor for predicting the growth and development of SMEs. Satisfaction level of SMEs towards credit facilities and the development of management skills and marketing facilitation were

recorded at moderate levels while the satisfaction level of SMEs towards financial literacy has shown a low level SME holders are highly satisfied with their current growth and development.

**Key words** - SME holders, Micro financial support, Growth and development of SMEs

## 1. INTRODUCTION

### 1.1. Background of the Study

SMEs play an important role in any economy through generation of employment, contributing to the growth of GDP, embark on innovation and simulating of other economic activities. Over the years SMEs have gained wide recognition as a major source of employment, income generation, poverty alleviation and regional development. In Sri Lankan context, successive governments have identified SMEs as an important strategic sector for promoting growth and social development and taken various steps to develop this vital sector. As a result over the years SMEs have gained wide recognition as a major

source of employment, income generation, poverty alleviation and regional development in Sri Lanka (Gamage, 2000). As in most Asia and Pacific, Sri Lanka too, has a majority portion of population living in rural areas which is estimated to be 78% of the country's total population. The small industries in the rural areas are the major source of employment and production of food and, therefore, the Sri Lankan villagers' livelihood.

### 1.2. Research Problem

A number of studies have been conducted on the effect of banking institutions on SMEs' growth. In many cases, bank lending has been a prime source of credit to SMEs. However, with the current economic downturn, the credit relationship between banks and SMEs has been associated with a lot of risk and in order to mitigate these risks, banks all over the world have used strict financing rules and collateral in financing SMEs' growth (Beck et al., 2004). Tagoe (2005) found out that there were long procedural issues such as a lot of paperwork, collateral security and high processing fees and prepayment charges issues that affected the growth of SMEs. There are a number of factors which interact to lead to SMEs' performance such as their sources of capital, the skills of its human resource and the satisfaction of their financial needs with the assistance of Micro Finance Institutions.

Lack of adequate finance from microfinance institutions is one of the most prominent issues facing SMEs seeking to expand and sustain their growth. The shortage of long-term finance was considered to be a major long-term constraint on SMEs' growth and expansion plans. Most SMEs rely too heavily on short-term loans from banking institutions, which are more expensive and therefore increase the risk of failure due to strict financing rules and procedures (Qadir, 2005). For SMEs, equity financing from Micro Finance Institutions could be more appropriate for their growth and expansion. Thus, it is more appropriate to study the effect of MFIs on the growth of SMEs.

Accordingly, this research aims to find an answer to the problem, whether there is an impact of micro financial support on growth of SMEs.

### 1.3. Objectives of the Study

Examine whether there is an impact of micro financial support on growth and development of SMEs. Micro financial support has comprised four components as

financing of SMEs, financial literacy, development of management skills and marketing facilitation.

Assessing the level of financing of SMEs, the level of financial literacy among SMEs, the level of development of management skills, the level of marketing facilitation & the level of growth and development of SMEs

### 1.4. Literature review

Various attempts have been done to examine the effect of financing SMEs by microfinance institutions on growth and development of SMEs. According to Wang (2013), microfinance plays a crucial role in the revenue and profit growth of SMEs. The study revealed that the SMEs with higher financial risk and lower level of productivity are more likely to seek microfinance. Furthermore, firm characteristics including product innovation efforts and managerial and entrepreneurial attitudes are the keys that determine the likelihood of receiving micro financing.

Babajide (2012) studied effects of Microfinance on Micro and Small Enterprises (MSEs) Growth in Nigeria and found strong evidence that access to microfinance does not enhance growth of micro and small enterprises in Nigeria. However, other firm level characteristics such as business size and business location were found to have positive effect on enterprise growth. The paper recommended a recapitalization of the Microfinance banks to enhance their capacity to support small business growth and expansion.

## II. METHODOLOGY

The study has utilized primary data and a sample of 100 SME holders has been chosen from Anamaduwa Divisional Secretariat Division in Puttalam District in accordance with the Morgan approach of sample selection through the purposive sampling technique, using a structured questionnaire. Multiple Regression Model has been utilized as the main data analyzing technique.

## III. RESULTS AND DISCUSSION

### 3.1. Reliability Test (Cronbach's Alpha)

Results of the Reliability Test

According to the results of reliability statistics, Cronbach's Alpha value of each variable is greater than 0.6 enabling to conclude that all the questions are reliable to measure the explanatory variables and the response variable; Growth and Development of SMEs.



**Table 3.1: Reliability Statistics**

Dimension	Cronbach's Alpha	Number of Items
Financing of SMES	0.667	5
Financial Literacy	0.766	5
Development of Management Skills	0.733	5
Marketing Facilitation	0.693	5
Growth and Development of SMEs	0.645	7

Source: Sample Survey, 2016

**3.2. Descriptive Analysis**

To assess the level of financing of SMEs, financial literacy, development of management skills, marketing facilitation and growth and development of SMEs; a Descriptive Analysis of mean and standard deviation were used. For the interpretation purposes, following levels of the mean were used.

- 1 ≤ X < 2.5      Low Level
- 2.5 ≤ X < 3.5      Medium Level
- 3.5 ≤ X < 5      High Level

Assess the Level of Financing of SMEs, financial literacy, development of management skills, marketing facilitation and growth and development of SMEs

**Table 3.2: Means and Standard Deviations**

Indicators	Mean	Standard Deviation
Financing of SMES	3.46	1.259
Financial Literacy	2.46	0.673
Development of Management Skills	3.47	0.930
Marketing Facilitation	3.33	0.753
Growth and Development of SMEs	3.74	1.116

Source: Sample Survey, 2016

It implies that financing of SMEs is at moderate level and it can be dispersed around the mean by 1.259. The mean value illustrates the financial literacy of SME holders is at low level. However 0.673 of responses on financial literacy can be dispersed from the mean value. The perception towards the development of management skills among SME holders is at moderate level and it can be dispersed around the mean by 0.930. The marketing facilitation is at moderate level and it can be dispersed around the mean by 0.753. The growth and development of SMEs is at high level and dispersed around the mean by 1.116.

**3.3. Correlation Analysis**

**Table 3.3: Results of the Correlation Analysis**

Dimension	Correlation Coefficient	P-Value
Financing of SMES	0.618	0.000
Financial Literacy	0.094	0.354
Development of Management Skills	0.918	0.000
Marketing Facilitation	0.632	0.000

Source: Sample Survey, 2016

According to the results of the Correlation Analysis; financing of SMEs(r = 0.618, P= 0.000), development of management skills(r = 0.918, P= 0.000) and marketing facilitation(r = 0.632, P= 0.000) are significantly correlated with the growth and development of SMEs. When concerning the correlation coefficients, financing of SMEs and marketing facilitation have recorded moderate level of positive correlation with the growth and development of SMEs while development of management skills has expressed strong positive correlation.

**3.4. Testing Parametric Assumptions**

**Normality Test**

As the sample of the present study comprised 100 elements, Shapiro – Wilk test was used to test the normality and the results of the test showed that the normality assumption is not violating (P= 0.080) revealing the possibility of parametric tests for the analysis.

**Multicolinearity Analysis**

It is possible to conclude that there is no correlation between explanatory variables and none of the explanatory variable was eliminated with the VIF values 1.392, 1.855 and 1.524 and it is less than 10 for financing of SMEs, development of management skills and marketing facilitation respectively.

**Test of Model Adequacy**

Durbin-Watson value of the model was recorded as 1.943 and it is approximately equal to two. Therefore, the residuals are uncorrelated and the assumption of independence is not violated.

**3.5. Regression Analysis**

**3.5.1. Model Summary**

Figure	Value
R	0.937
R <sup>2</sup>	0.879
Adjusted R <sup>2</sup>	0.875
Standard Error of Estimation	0.395

*Source: Sample Survey, 2016*

According to the results of the model summary, 87.9% of the total variation of growth and development of SMEs ( R<sup>2</sup> = 0.879) has explained by the financing of SMEs, development of management skills and marketing facilitation.

**3.5.2 Analysis of Variance**

**Table 3.5: Results of the Analysis of Variance**

Model	Sums of Squares	DF	F	Significance Value
Regression	108.289	3	231.779	0.000
Residual	14.951	97		
Total	123.240	100		

*Source: Sample Survey, 2016*

ANOVA concluded that the overall fitted model can be applied significantly for predicting the growth and development of SMEs.

**3.5.3 Summary of the Coefficient Table**

**Table 3.6: Results of the Coefficient Table**

Predictor	Coefficients (β)	Standard Error	Sig.
Constant	-0.573	0.191	0.003
Financing of SMEs	1.157	0.037	0.000
Development of Management Skills	0.894	0.058	0.000
Marketing Facilitation	0.200	0.065	0.003

*Source: Sample Survey, 2016*

According to the coefficients table, financing of SMEs, development of management of skills and marketing facilitation were significant with P values less than 0.05.

Based on the results of the regression analysis, the equation of the regression can be depicted as follows.

$$Y = -0.573 + 0.157X_1 + 0.894X_2 + 0.200X_3$$

Where;

- Y = Growth and Development of SMEs,
- X<sub>1</sub> = Financing of SMEs,
- X<sub>2</sub> = Development of Management Skills  
and
- X<sub>3</sub> = Marketing Facilitation

β Value of financing of SMEs suggests that, if financing of SMEs (credit facilities) is increased by one unit, growth and development of SMEs will increase by 0.157 units when all of other variables remain constant and similarly the coefficient of the development of management skills indicates, when it is increased by one unit, growth and development of SMEs will also increases by 0.894 units. Marketing facilitation has also shown a positive relationship with growth and development of SMEs. Marketing facilitation leads to increase the growth and development of SMEs by 0.200 units. Development of management skills has the highest β value as 0.894 and it is the most influential factor for the growth and development of SMEs. Moreover, financing of SMEs, development of management skills and marketing facilitation positively influence for the growth and development of SMEs.

## IV. CONCLUSIONS

The present study mainly aims to find an answer to whether there is an impact of micro financial support on growth of SMEs. Micro financial support has comprised four components as financing of SMEs, financial literacy, development of management skills and marketing facilitation.

According to the results of the correlation analysis, financing of SMEs, development of management skills and marketing facilitation were significantly correlated with the growth and development of SMEs and only financial literacy was insignificant with the growth and development of SMEs. When concerning the correlation coefficient, financing of SMEs and marketing facilitation have recorded moderate level of positive correlation with the growth and development of SMEs while development of management skills have expressed strong positive correlation.

Results of the regression analysis revealed that, financing of SMEs (credit facilities), development of management skills and marketing facilitation cause to increase the growth and development of SMEs and development of management skills could be identified as the most crucial factor for predicting the growth and development of SMEs.

According to the results of descriptive analysis, Satisfaction level of SMEs towards the credit facilities, development of management skills and marketing facilitation were recorded at moderate level while satisfaction level of SMEs towards the financial literacy has shown low level and SME holders highly satisfied with their current growth and development.

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# THE EFFECTS OF CORPORATE GOVERNANCE ON CAPITAL STRUCTURE: A STUDY OF LISTED MANUFACTURING COMPANIES IN SRI LANKA

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**Abstract** – Capital structure decisions are vital for any organization in order to identify the optimal combination of debt and equity, which will enable to achieve an organization's ultimate objective of shareholder wealth maximization. Good corporate governance practices prevailing in the organization would ensure that the managers are acting for the best interest of the owners of an organization. The study attempts to identify the effects of corporate governance on capital structure in firms listed in the manufacturing sector in Sri Lanka. A sample of 34 manufacturing entities were selected out of 38 companies based on the availability of data for the period of 2012 to 2016. The study employed corporate governance variables of board size, proportion of non-executive directors, director ownership and CEO duality. The capital structure was measured using Total Debt Ratio (TDR) as the dependent variable. The study also employed the control variables of firm size and profitability. The variables were empirically tested using multiple regression analysis. The results revealed that proportion of non-executive directors, CEO duality and director ownership tend to have positive and significant relationship with capital structure while the association between board size and capital structure depicts negative, insignificant relationship.

**Key Words** - Corporate Governance, Manufacturing Sector, Listed Companies

## I. INTRODUCTION

Global financial crisis and other corporate scandals across the globe stresses on the vitality of corporate governance and financial management for an organization in order to deal with the effects of unexpected crises and uncertainties. Separation of ownership and control in the businesses as being identified by Jensen and Meckling (1976), gives rise to the agency problem within the organizations which is the prime reasoning behind the need for effective corporate governance. In an organizational context, shareholders are being identified as the principals while the managers are agents acting on behalf of the principals. Baysinger and Hoskisson (1990), insisted that managers might be satisfiers rather than striving to maximize returns such that they tend to play it safe with the aim of survival without paying much attention on enhancing the value of the firm. On contrary, the objective of shareholders is to maximize their wealth giving rise to the agency conflicts between the said parties.

The countries that have implemented sound corporate governance practices generally experienced a vigorous growth of corporate sector, and grasp more ability in attracting capital to lubricate the economy. Ehikioya (2009), suggested that a well-defined and a functioning corporate governance system would help a firm to attract investments, raise funds and strengthen the foundation for the firm. Good governance focuses not solely on shareholder wealth maximization but also on reducing the cost of fund (Sheikh & Wang, 2012).

Successful selection and use of capital is one of the key elements of the firms' financial strategy. The literature in capital structure began with the seminal work by Modigliani and Miller (1958), on the irrelevance of capital structure. Since then, capital structure continues to be a topic of interest in finance. Modigliani and Miller (1958), pointed out the fact that in a perfect market, in the absence of corporate taxes and bankruptcy cost, capital structure is irrelevant for the value of the firm.

Capital structure decisions are crucial for any business organization such that the decision is important because of the need to maximize returns to various organizational constituencies and also because of the impact such a decision has on an organization's ability to deal with its competitive environment (Aboh, 2007).

Managers are held responsible in selecting the optimum way of financing for the best interest of the shareholders. Debt creation enables the managers to effectively bond their promise to pay out future cash flows. When firms take strategic decisions via issuing debt, firms should be responsible to pay interest from the future cash flows. Meantime increased leverage also involves costs in terms of bankruptcy cost as well as the agency cost of debt will also rise (Ajanthan. 2013). Thus, it reveals the importance of good governance in order to reduce such costs associated with debt capital.

Claessens, Djankov, Fan and Lang (2002), explained that by having better corporate governance, firms can benefit via greater access to external finance. As suggested by Liao, Mukherjee and Wang (2012), good governance enables the companies to utilize information in an effective manner which would lead to a reduced cost of capital and thereby to make effective and faster capital structure decisions.  
Research Issue

Enron, World com, Asian financial crisis and series of other corporate scandals in United States of America and elsewhere, reminded the importance of sound corporate governance mechanisms over past few decades. Nevertheless, in the recent past, certain Sri Lankan companies too were victims of the catastrophes of various corporate governance issues such as, Golden Key scandal. Thus, corporate governance can be identified as a timely issue persisting in the country.

The nexus between corporate governance and capital structure has not been comprehensively explored in

developing countries specially in the Sri Lankan context. Extant literature on corporate governance is heavily focused on corporate governance and firm performance even in Sri Lankan context (Achchuthan & Kajanathan, 2013; Velnamby, 2013; Ujunwa, 2012; Ehikioya, 2009) Therefore, this study attempts to fill the gap in the literature by taking into consideration the various corporate governance measures and their effect on the capital structure decisions of the organizations in the manufacturing sector, with relevance to the firms listed in Colombo Stock Exchange (CSE). Therefore, the research questions are identified as;

- 1)What are the measures of corporate governance in Manufacturing Sector of Sri Lanka?
- 2)What is the impact of measures of corporate governance on capital structure in listed manufacturing companies in Sri Lanka?

The research objective is to explore the effects of corporate governance on corporate capital structure with relevance to manufacturing entities listed in Sri Lanka.

## II. LITERATURE REVIEW

The need for corporate governance within the organizations stems from agency theory which is a contract under which the principal engages another person (the agent) to perform some service on his behalf, which involves delegating some decision-making authority to the agent (Jensen & Meckling, 1976). In order for the shareholders to ensure that managers are working to the best interest of the shareholders, they have to incur certain costs called "agency cost" (Vakilifard, Gerayli, Yanesari & Ma'atooifi, 2011). Jensen and Meckling (1976), defined such costs as the sum of, the monitoring expenditure by the principal, the bonding expenditure by the agent and the residual loss. Ujunwa (2012), stated that corporate governance practices are designed to resolve issues associated with agency problems and thereby to protect overall interest of stockholders. Accordingly, adequate monitoring or mechanisms need to be used in order to reduce the conflict of interest between shareholders and management, among shareholders as well as between debt holders and firms (Fama & Jensen, 1983).

Study of capital structure is given utmost importance under financial literature. Modigliani and Miller (1958), argued that under perfect capital markets in the absence of

taxes and transaction cost, a firm's market value and cost of capital remain invariant to the capital structure changes. The value of the firm depends on the earnings and risk of its assets rather than the way in which assets have been financed. Accordingly, even though debt appears to be cheaper than equity, when firm increases the debt level, equity will become riskier and cost of equity rises as a result. Modigliani and Miller (1963), relaxed the constraints and introduced corporate tax into the model concluding the fact that increase of debt level can increase the value of the firm due to deductibility of interest charges for tax computation. Among other capital structure theories, pecking order theory assumes that firms generally prefer internal finance to external finance (Myers, 2001). This is based on the assumption that information asymmetries are relevant only for external financing, which indicates that managers know more about their companies' prospects, risks and values than outside investors. He further states that if external funds are required for capital investment, firms will issue the safest security first that is debt before equity.

Corporate governance has been identified in prior studies (Berger, Ofek & Yermack., 1997; Wen et al., 2002; Sheikh & Wang, 2012) to influence the capital structure decisions of the firms. In Sri Lankan context, Kajanathan, 2012; Achchuthan, Kajanathan and Sivathasan, 2013; De Mel and Dassanayake, 2015, have found significant relationship between corporate governance and capital structure in the firms listed in Colombo Stock Exchange. Claessens et al (2002), suggests that good corporate governance practices enable the organizations to have better access to financing and reduce overall cost of debt by winning the trust of investors.

Board size has been identified as an important determinant of corporate governance in various literature (Wen et al., 2002; Berger et al., 1997) such that an effective board is essential to the success of an organization. As stated by Pfeffer (1972), CEO cannot dominate a bigger board due to the fact that collective strength of its members is higher and can resist the irrational decisions of a CEO. On flip side, Amason and Sapienza (1997), argues that large boards are more prone to conflict among directors and further according to Lipton and Lorsch (1992), large boards could be less effective due to the fact that some directors may free-ride on the efforts of others. They also stated that when a board consist of more than ten members it becomes more inconvenient for them to express their ideas and opinions.

Board of directors comprises of executive directors and non-executive directors (NED). Weir, Laing, and McKnight (2002), defines executive directors as full-time employees of an organization with clearly defined role and responsibilities while NED do not serve as the employees of the company. The composition of the board structure is an important mechanism because the presence of NED represents a means of monitoring the actions of executive directors and of ensuring that they act in accordance with protecting shareholder interest (Fama, 1980).

when the managers' ownership of the firm's stocks increases, it would help alleviate agency conflict between managers and owners (Jensen and Meckling, 1976). This is because, a manager who possess large proportion of company shares, has more incentives to maximize job performance and thereby to enhance company performance. Further according to Aboh (2007), directors too should hold some amount of financial risk as shareholders, which would give them an incentive to act in the best interests of shareholders.

CEO duality is another corporate governance variable. It is a corporate leadership structure, that merger the positions of chairman of the board of directors and CEO. If CEO duality exists, "this signals the absence of separation of decision management and decision control" (Fama & Jensen, 1983, p. 314). They further stated that since the chairman has the greatest influence over the actions of the board, the separation of decision management and decision control is compromised when the chairman of the board is also the CEO of the firm. Therefore, two-tier leadership structure can more effectively control the agency problems associated with the separation of ownership and control.

### III. METHODOLOGY

The conceptual framework developed for the study is depicted in Figure 1. It incorporates the corporate governance variables intended to use in the study in terms of, board size, non-executive directors (NED), director ownership, director remuneration and Chief Executive Officer (CEO) duality. Further capital structure will be determined in terms of Total Debt Ratio. Study would also employ the control variables namely, firm size and profitability.

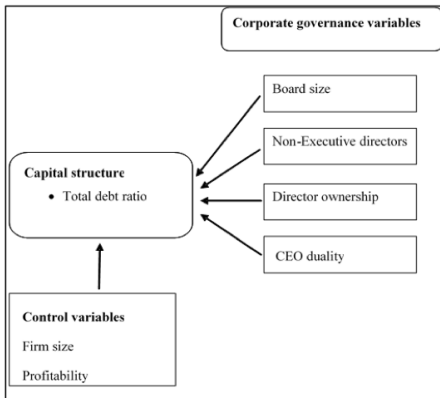


Figure 1: Conceptual Framework

Source: Author

In examining the corporate governance on capital structure in Sri Lankan listed manufacturing companies, the study employs panel data methodology. The general form of panel data model can be illustrated as follows;

$$Y_{it} = \alpha + \beta X_{it} + \mu_{it}$$

Where *i* denotes the cross-section dimension and *t* denotes the time dimension.  $Y_{it}$  is the firm *i*'s capital structure at time *t*. Further,  $\alpha$  is the intercept of the function while  $\beta$  represents the corresponding coefficient.  $X_{it}$  contains the set of explanatory variables in the estimation model.  $\mu_{it}$  is the disturbance term.

The study employs the following model.

$$TDR_{it} = \beta_0 + \beta_1 BS_{it} + \beta_2 NED_{it} + \beta_3 DOWN_{it} + \beta_5 CEODU_{it} + \beta_6 ROA_{it} + \beta_7 FSIZE_{it} + \mu_{it}$$

Where,

- $TDR_{it}$  = Total debt ratio of firm *i* at time *t*
- $LTDR_{it}$  = Long term debt ratio of firm *i* at time *t*
- $BS_{it}$  = Board size of firm *i* at time *t*
- $NED_{it}$  = Non-executive directors of firm *i* at time *t*
- $DOWN_{it}$  = Directors ownership of firm *i* at time *t*
- $CEODU_{it}$  = CEO duality of firm *i* at time *t*
- $ROA_{it}$  = Return on assets of firm *i* at time *t*
- $FSIZE_{it}$  = Size of firm *i* at time *t*
- $\beta_0$  = Intercept
- $\beta_1 - \beta_8$  = Coefficients of the explanatory variables
- $\mu_{it}$  = Error term

As adopted in many of the prior researches in this area, this study also employed pooled Ordinary Least Squares (OLS) method in order to estimate the coefficient. (Sheikh & Wang, 2012; Abor, 2007; Bodhagi and Ahmdapour, 2010; Masnoon and Rauf, 2010; Abor, 2007; Wen et al.)

Table 1: Definition of variables

Variable	Definition
<b>Dependent variables</b>	
Total debt ratio (TDR)	Ratio of total debt to total assets. Total debt is the sum of short term debt and long term debt
<b>Explanatory Variables</b>	
Board size (BS)	Logarithm of number of board members
Proportion of Non-executive directors (NED)	Ratio of non-executive directors to total board members
Director ownership (DOWN)	Ratio of shares held by the directors to total outstanding shares
CEO duality (CEODU)	A dummy variable. "1" if CEO is also the chairman. "0" otherwise
<b>Control Variables</b>	
Firm size (FSIZE)	Logarith of total assets
Profitability (ROA)	Returns of assets (ROA). Ratio of net profit after tax to total assets

Source: Author

In examining the relationship between corporate governance and capital structure, the organizations that have been listed on the Colombo Stock Exchange (CSE) over the period of 5 years spanning from 2012 to 2016 were taken into consideration. The study focuses on manufacturing sector. Out of 38 listed manufacturing entities in Sri Lanka, 34 companies were selected based on the availability of data for years under consideration. The required data for the study were gathered from secondary sources. Accordingly, the data and information required were collected from the annual reports of the listed entities in the selected sample.

## IV. FINDINGS AND DISCUSSION

As depicted in Table 2, the significance value is less than the significance level, thus there is enough evidence to state that the model is significant at 5% significant level.

Therefore, it shows that corporate governance practices contribute significantly to capital structure ( $F=4.989$ ;  $P<0.05$ ). Moreover, as depicted in Table 3, the model predicts 12.5 % of the variation found.

**Table 2: ANOVA**

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.790	6	.298	4.989	.000 <sup>b</sup>
	Residual	9.627	161	.060		
	Total	11.417	167			

Source: Author

**Table 3: Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.396 <sup>a</sup>	.157	.125	.244536510992511

In order to determine the presence of multicollinearity among the independent variables used in the research, calculation of Tolerance Test and Variance Inflation Factor (VIF) was being used. The results are presented in Table 4. Accordingly, none of the tolerance level is less than or equal to 1, and also VIF values are less than 10 Accordingly it demonstrates that there does not exist the problem of multi-collinearity.

**Table 4**

Model		Collinearity Statistics	
		Tolerance	VIF
1	(Constant)		
	BS	.847	1.181
	NED	.923	1.084
	DOWN	.908	1.101
	CEODU	.883	1.132
	ROA	.784	1.275
	FSIZE	.694	1.441

Source: Author

The results of multiple regression analysis are depicted in Table 5.

**Table 5: Multiple regression analysis**

Model		Standardized Coefficients	t	Sig.
1	Beta (Constant)		3.815	.000
	BS	-.082	-1.041	.299
	NED	.183	2.434	.016
	DOWN	.227	2.986	.003
	CEODU	.229	2.967	.003
	ROA	.082	1.009	.315
	FSIZE	-.267	-3.077	.002

Source: Author

According to the regression results, board size depicts inverse but insignificant relationship with Total Debt Ratio. Other corporate governance variables employed in the study in terms of, proportion of non-executive directors, director ownership, CEO duality show positive and significant relationship with the capital structure.

Among the control variables used in the study, profitability measured in terms of Return on Assets (ROA), tends to have positive but insignificant association with Total Debt Ratio. Firm size shows a negative and significant relationship with the capital structure.

Larger boards are expected to have representation of people with diverse backgrounds and thus anticipated to bring knowledge, wider perspective and intellect to the board (Mollah, Farooque and Karim, 2012). Berger et al., (1997), states that firms with larger board membership have low leverage or debt ratio. Their argument portrays that, a large board would lead to strong pressure in the corporate board room to pursue lower leverage as a way of enhancing firm performance. Findings of Brenni (2014), also consistent with this, stating that board size has significant negative relationship with leverage, in the study based on listed real estate companies in United Kingdom. Wiwattanakantang (1999), Vakilifard, et al., (2011), Bodhagi and Ahmadpour (2010) also found a negative relationship between board size and leverage. As per the study in Sri Lankan listed manufacturing entities, larger the board size, lower will be the use of leverage. In prior studies conducted in Sri Lankan context, De Mel and Dassanayke (2015), reveal similar results and moreover, Kajanathan (2012), Achchuthan et al. (2013), have stated that capital structure is not affected significantly by the number of members on the board.



The relationship between proportion of NED on the board and capital structure reports positive significant results. This regression result is consistent with prior studies of Aboh (2007), Jensen (1986) and Bereger et al. (1997), and Sheikh and Wang (2012). Aboh (2007), stated that high proportion of outside directors is believed to be associated with high leverage positions due to the fact that existence of NED could lead to better management decisions helping firms in attracting better resources. This is because external board members may have sound knowledge and useful information on financing facilities. The Sri Lankan Code of Best Practice on Corporate Governance (2013), mentions that the board should include NED of sufficient caliber and number, for their views to carry significant weight in the Board's decisions. The Board should include at least two Non-Executive Directors or such number of NED equivalent to one third of total number of directors, whichever is higher (Principal A.5.1). This has been satisfied by listed manufacturing entities in Sri Lanka.

Regression results show an inverse relationship between director ownership of shares and capital structure in listed manufacturing entities in Sri Lanka. Friend and Lang (1988), established a negative relationship between capital structure and CEO shareholding. Such relationship is also confirmed by Fosberg (2004), and Sheikh and Wang (2012). According to Sheikh and Wang (2012), the negative relationship between managerial ownership and capital structure indicates that increased managerial ownership aligns the interests of managers with the interests of outside shareholders and reduces the role of debt as a tool to mitigate the agency problems.

There exist a positive and significant relationship between CEO duality and capital structure. As per the Code of Best Practice on Corporate Governance (2013), a decision to combine the posts of chairman and CEO in one person should be justified and highlighted in the annual report (principle A.2.1). Fosberg (2004), found a positive but insignificant relationship between CEO duality and amount of debt being used. This was further confirmed in subsequent literature by, Aboh (2007) and Bokpin and Arco (2009), based on the studies relating to Ghanaian listed entities.

According to Aboh (2007), such positive relationship is important in avoiding conflict between CEO and the board chairman, where the two personalities are different. Hence that would enable the CEO in a one-tier system to pursue an effective debt strategy based on the advice of the

board. Moreover, Vakilifard et al. (2011), also suggested a significant and positive relationship between CEO duality and capital structure.

Among the control variables used in the study, profitability measured in terms of Return on Assets (ROA), shows a positive but insignificant relationship with Total Debt Ratio (TDR). Brenni (2014), and Bodaghi and Ahmadpour (2010), found a positive relationship with profitability and leverage which is supported by trade-off theory disagreement with the pecking order theory where highly profitable firms will first utilize retained earnings therefore suggesting lower external financing needs. For profitable manufacturing firms, obtaining better negotiations for debt financing would be easier in order to gain tax shield benefits. As far as firm size is concerned, the larger the firm size lower will be the Total Debt Ratio with respect to listed manufacturing entities in Sri Lanka.

## V. Conclusion

Capital structure decision is one of the crucial decisions taken in an organization. The study attempted to identify the effects of corporate governance on capital structure of manufacturing entities listed in Colombo Stock Exchange. Empirical results indicate that there exists a significant relationship between corporate governance and capital structure in listed manufacturing companies in Sri Lanka. The corporate governance variable of, board size, reported a negative, insignificant relationship with capital structure, measured in terms of Total Debt Ratio. Other corporate governance variables used in the study, proportion of non-executive directors, CEO Duality, director ownership showed positive, significant association with Total Debt Ratio. Study also employed the control variables of firm size and profitability. Profitability measured in terms of Return on Assets (ROA) reported a positive, insignificant association with Total Debt Ratio while firm size is negatively correlated with capital structure.

The empirical evidence documented in the study tends to have various implications for directors and managers, decisions makers, regulators and policymakers, investors and researchers. The findings suggest that good governance is vital when firms making decisions on the method of financing and reminds the importance of adhering to corporate governance guidelines.

Further, investors will be facilitated in terms of identifying entities that have established good governance practices.

Accordingly, investors may undertake their investment decisions with confidence.

Future research can be carried out with taking ownership structure into consideration in order to determine its impact on capital structure decisions of Sri Lankan listed firms. Ownership structure is also a vital aspect of corporate governance practices such that prior researches too have incorporated ownership patterns (Shiekh & Wang, 2012; Bodaghi & Ahmadpour, 2010). However, in Sri Lankan context, obtaining information with this regard requires substantial analysis due to ultimate ownership. Hence future research is opened with respect to detailed analysis of ownership structure in order to determine its impact on capital structure decisions of Sri Lankan listed firms.

The scope of the study was limited to corporate governance practices and their effects on capital structure merely to public quoted entities in the manufacturing sector of CSE. Nonetheless, evaluation of corporate governance practices with respect to other sectors can be analyzed in further research.

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# DEVELOPING AN ELECTRONIC ACCIDENT REPORTING SYSTEM TO SRI LANKAN APPAREL INDUSTRY

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**Abstract** - Under-reporting of occupational accidents is becoming a major concern where management of occupational safety and health is considered. Drawbacks of the current accident reporting system have been identified as the main cause of accident under-reporting in the industrial sector. Thus, this study is aimed to develop an electronic accident reporting system and a mobile app to overcome the prevailing issues of the manual system and thereby reduce the under-reporting of occupational accidents in the apparel industry. Four objectives were formed to study the accidents/incidents, the current accident reporting system in the Sri Lankan apparel industry, the requirement of an electronic accident reporting system to the Sri Lankan apparel industry and to develop an electronic accident reporting system to the Sri Lankan apparel industry. The study was structured in several steps. In-depth knowledge was gained regarding the research stream which was sorted upon the degree of relevance to the study. Semi-structured interviews were conducted with industry experts to identify the requirement of an electronic accident reporting system, issues of the current system and needed improvements. The Findings of the interviews revealed that under-reporting of accidents mostly happen due to the inefficiency of the manual accident reporting system currently used in the industry. The existing system was found to be discouraging and rigid. Suggestions were provided by the professionals and OSH experts to improve the current system. Once the system and the app were developed, they were validated by an expert survey and a test run respectively.

**Keywords** - Occupational Safety and Health, Accident Under-reporting, Electronic Accident Reporting System

## I. INTRODUCTION

Occupational Safety and Health (OSH) is one of the major concerns of any organization that seeks to sustain. Apparel industry is one of the mass producing industries in Sri Lanka (Kapuge & Smith, 2007). It is also a sector with higher percentage of OSH issues (Madurawala, 2013). According to the Factories Ordinance (1942), in Sri Lanka, all the industrial accidents are essential to be reported to the Department of Labour. About 15-25% of accidents has been recognized to be under-reported in manufacturing sector (Beaumont, 2007). This under-reporting can be problematic when it comes to conducting in-depth studies on OSH (Psarros, Skjong & Eide, 2009). The reason for the accidents/incidents to be under reported is identified as the complexity of the current accident reporting system (Probst, 2013).

## II. ACCIDENT REPORTING SYSTEMS

An accident reporting system ensures all workplace parties are aware of how to report a work-related injury to the authorities and to the appropriate persons designated by the employer. Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995 (RIDDOR)

requires the reporting of work-related accidents, diseases and dangerous occurrences. The information enables the enforcing authorities to identify where and how risks arise and to investigate serious accidents. There are two types of accident reporting systems in general industry practice. They are manual accident reporting system and electronic accident reporting system.

**A. Manual accident reporting system**

According to New Jersey Department of Education (2008), if accident need to report, injured person should associate with a vocational – technical education program, courses, career orientation course, or structured learning experience and with the treatment provided by a licensed physician. Further, considering the reporting process, when accident reporting, it requires manually filled accident form with following details as country, district, school, incident/structured learning experiences , description of accident, date and time of accident, narrative description of accident, corrective action taken and report completed by. Moreover, Department of Health (2013) stated that manual accident reporting requirements as, it is need to respond to the most senior member of staff and they require to complete the accident form by authorised officer or SRS program manager by submitting details of who was involved, how, where and when the accident occurred, who was injured and what action is being taken in response to the accident. Consequently, manual accident reporting system consists of unique forms which need to be filled manually by authorized person and process of manual reporting is complex in nature.

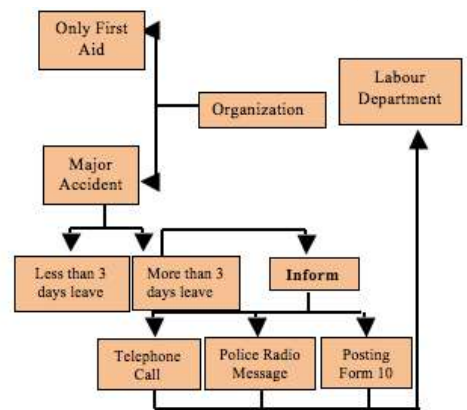
**B. Electronic accident reporting system**

According to Safety, Health and Environment Unit (2012), through the electronic accident reporting system accident can be reported instantly. Moreover Reporting of Injuries, Diseases and Dangerous Occurrences Regulation (RIDDOR Regulation) (2013), mentioned accident records such as, broken bones or dislocation, amputation, injury from electric shock or serious burns, loss of sight or chemical burn to the eye, crush injuries affecting the head or torso, injury as a result of confined space work that results in hypothermia and loss of consciousness due to head injuries, chemicals, toxins, infected materials or asphyxia can send through online media. University Collage Landon maintain online incident reporting system and it is system that have complete detail reporting and as well as the PDF report of the entered details (SafetyNET

online incident reporting, 2011). Moreover, University week (2004) mentioned that university employees can access to the system through University Employee Health and Safety Department web site. Simple Accident Reporting App (SARA) altremis App Venture Ltd was developed as iPhone app to report incidents, near – misses and accident. SARA mainly focused on immediate reporting without paper work and save employees from accidents (Altermis Ltd, 2012). According to Department of Health and Safety, employees, students, visitors and contractors within the premises should involve to the accident reporting to Department of Health and Safety (Head of Health and Safety, 2014). Walsh and Antony (2007), mentioned that electronic accident reporting was most suitable report accident comparing quality and cost of accident reporting systems.

**III. SRI LANKAN PRACTICE OF ACCIDENT REPORTING**

Considering of accident reporting system in Sri Lankan context still it is manual reporting system. Accident reporting it is govern under Factories Ordinance No.45 of 1942 and under that General Register should be kept in every factory as mentioned in Section 92 of Factories Ordinance No.45 of 1942 (Factories Ordinance No.45 of 1942, 1942). According to Factories (Amendment) Law No 12 of 1976 Sec.61 it is mentioned that written notice is to be sent to the District Factory Inspector Engineer by using Form 10 and such an occurrence it should be inform by telephone immediately and it should be confirm by transmitting a Police Radio message to the D.F.I.E. (Factories Ordinance No.45 of 1942, 1942).



*Accident reporting process in Sri Lanka*

Generally, Sri Lankan apparel industry follows Factories Ordinance requirements. According to District Factories Inspector Engineers (DFIE) they inspect whether industry follow the Factories Ordinance requirements of accident reporting. In industry side they are legally govern to report accidents and apart from it organizations has individual norms to collect accident records. According to industry experts, there are huge financial and non-financial cost of accidents it was significant reason to take more attention on accident details. Further to DFIEs, large amount of paper work, less of staff, complexity of current system and human errors are leading difficulties of current accident reporting system. Large amount of paper work, high paper waste, difficulties of storing documents, complexity of current accident reporting system were misled to accident under reporting.

#### IV. METHODOLOGY

Through the literature review, it was discovered that an under reporting condition has occurred in reporting work place accidents and incidents in apparel industry of Sri Lanka. The main reason was found to be the complications which are present in the current accident reporting system. Under 3 phases, data were collected. Pilot study was carried out among the two District Factory Inspector Engineers (DFIEs) by using semi structured interviews. 3 case studies were conducted having one safety executive, an accident record keeper and lower level employees for each case. Semi structured interviews were conducted with safety executives and accident record keepers, mainly under the following headings, current accident reporting system, difficulties of manual accident reporting system and requirement of electronic accident reporting system to collect further information. A questionnaire survey was conducted with lower level employees to identify manageable level of functional features of mobile app within lower level employees. Content analysis, cross case analysis and analysis by using charts used to analyse the collected data and for content analysis N-Vivo software was used. For system validation industry experts were selected User – friendliness of functional features of developed mobile app was validated by a questionnaire survey among lower level employees.

#### V. DEVELOPMENT OF ELECTRONIC ACCIDENT REPORTING SYSTEM

According to the experts, reporting system should be user friendly to report accidents and it should feature user friendly command buttons, easy to collect accident records, instantly notification facility and it should direct communication with industry. Industry require the system with facilities of user friendly functional features, quick data entering facility, instantly notification facility and easily documents sending facility.

When considering mobile app it should facilitate to manage even lower level employees in industry and to verify the feasibility of use mobile app in lower level employee a simple questioner was developed. Consider of the findings of questioner survey large amount of employee aware with the current organization accident reporting system but drastic of employees were expressed under satisfaction of the current accident reporting system. Other than writing description most of the employee convenient with the functional features of mobile phone and majority of the employee stated that mobile app is appropriate to the accident reporting.

Considering above factors developed accident reporting system naming “eARS” web base system and “eR” mobile app. “eARS” system were arrange as follow,



Figure 2 Login interface of eARS

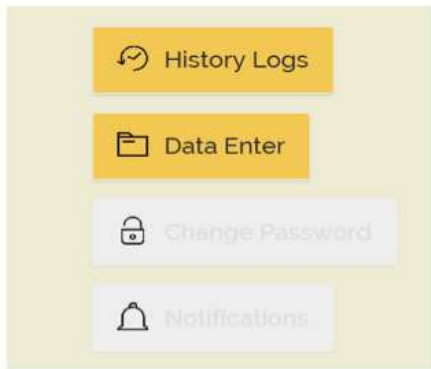


Figure 3 Facilities of eARS

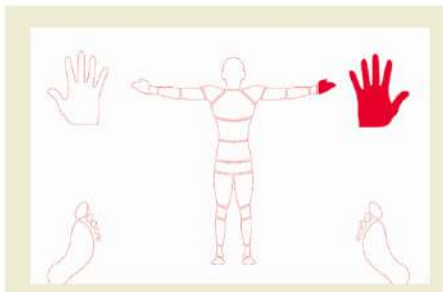


Figure 4 Interface to indicate injured body part



Figure 5 Further attachment



Figure 6 Final interface of the system

When considering mobile app it should facilitate to manage even lower level employees in industry and to verify the feasibility of use mobile app in lower level employee a simple questioner was developed. Consider of the findings of questioner survey large amount of employee aware with the current organization accident reporting system but only few of the employees expressed satisfaction towards the current accident reporting system. Other than writing description most of the employee convenient with the functional features of mobile phone and majority of the employee stated that mobile app is appropriate to the accident reporting. The interfaces of eR are as follows.

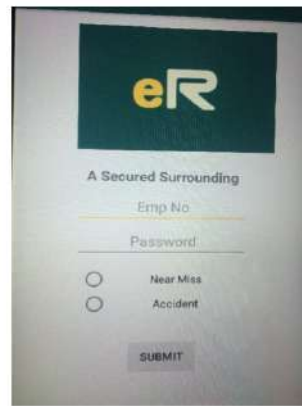


Figure 7 First interface of eR app



Figure 8 Details of accident

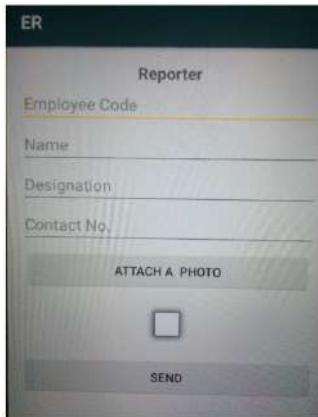


Figure 9 Details of reporter and photo evidence

According to this study, validation of the system was conducted in two steps as follows,

**Step 01**

Fundamental intention of this step is to check the comprehensiveness of the developed system and app and there conducted expert survey with the two District Factory Inspector Engineers.

**Step 02**

This step was arranged to check the feasibility user friendliness of the developed app. For the validation survey there were selected 30 lower level employees in sewing department, maintenance department and security department. Considering the opinions, comments and responses received for the developed “eR” App and the eARS it was evident that these contribute to mitigate the existing issues related to accident reporting in the industry. According to respondents, level of satisfaction of functional features of “eR” app can be elaborate as follows, (rate 1 is least and 5 is the highest)



Figure 10 Satisfaction level of functional features in eR app

**VI. CONCLUSIONS**

To create an accident free environment in industry, it is very essential to have better accident reporting system to prevent future accidents. Complexity of current accident reporting process, large amount of paper work are most significant causes to accident under – reporting. In world context many advanced methods are used in accident/ incident reporting minimizing the complexity of accident reporting process. Therefore, this research was carried out to develop an electronic accident reporting system to Sri Lankan apparel industry with considering requirements of Sri Lankan apparel industry. “eARS” web base accident reporting system and “eR” mobile app to were developed to Sri Lankan apparel industry while achieving the research aim and the objectives.

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valuable time to make this dissertation a reality. Each and every one of them are reminded with heartiest gratitude and thankful thoughts who showed the path to make this dream come true.

# DISASTER MITIGATION STRATEGIES IN URBAN DEVELOPMENT: WITH SPECIAL REFERENCE TO KADUWELA AREA

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**Abstract** - Disasters are unavoidable occurrences that cause damage to the life style of, not only humans but also animals. Wherever the country is and whatever the location of the country is in the world, it is the truth and law that they have to face disasters in many ways, not only natural disasters but also man-made disasters. Out of natural disasters and man-made disasters, natural disasters are the most important as they cannot be avoidable. This study examines the impact of structural mitigation strategies and non-structural mitigation strategies on the effectiveness of flood mitigation strategies in urban development. In particular, the study focuses flood disasters in Sri Lankan urban cities with special reference to the Kaduwela geographic area. The study employed a questionnaire and unstructured interviews for the data collection. The study finds that structural flood mitigation and non-structural flood mitigation strategies influence the effectiveness of Flood mitigation strategies in urban development. The study also discusses policy implications in mitigating natural disasters.

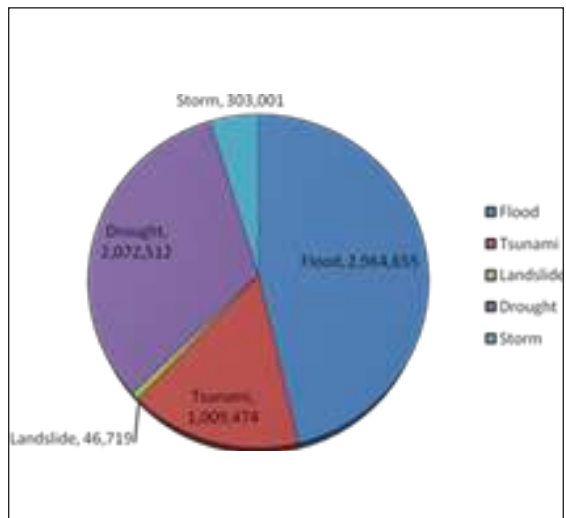
**Keywords** - flood, structural mitigation, non-structural mitigation

## I. INTRODUCTION

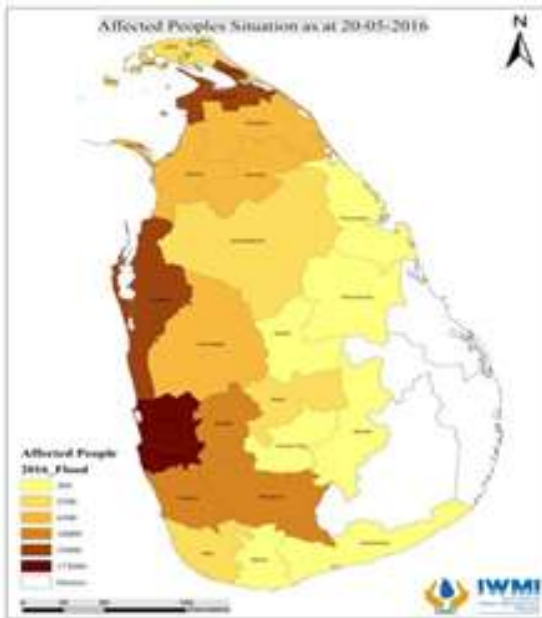
Sri Lanka is a country which has a very significant and remarkable location, which is considered less disaster prone area (hazards and disasters are very rare) comparing to other countries and Island in the Indian Ocean.

Although as the other countries in the world, Sri Lanka is similarly prone to particular, different kind of natural disasters which are non-avoidable, with increasing losses for life and property in the past few decades.

Out of natural disasters most urban areas are vulnerable to the flood disaster and comparing the rural and the urban areas, urban areas are the highly vulnerable to the flood disasters.



**Figure: 1 - number of people affected by different disasters from 2010 to 2015**



**Figure: 2-Areas where people affected by flood as at 20.05.2016**

The above two figures shows that flood is the most vulnerable disaster and urban areas are affected more than the rural areas by flood disaster. The current study addressed the problem, if there are several mitigation projects to avoid the flood disaster in urban areas, the risk and the vulnerability does not reduced to the level that they expected, it is important to study the reasons behind it as here are number of mitigation strategies are in currently. The main objective of this study is to identify the current flood mitigation strategies in Kaduwela area since current study narrow down to the Kaduwela area.

### A. Research Objectives

The primary objective of the research is to identify the disaster mitigation strategies in Kaduwela to reduce the risk and the impact of flood disaster.

Secondary objectives are, firstly, analyse the current disaster mitigation strategies that implemented by the Disaster Management Centre to reduce the risk of flood disaster in Kaduwela. Secondly, to find out reasons, why still Kaduwela gets more damage because of the flood disaster, if there are disaster mitigation projects and finally to provide, new and technological awareness programs and mitigation strategies to overcome the flood disaster.

### B. Significance of the Research

This study would be significant in three different aspects namely, theoretical, empirical and stakeholder significant. Theoretically Flooding in the cities and the towns is a current phenomenon caused by increasing occurrence of heavy rainfall in the short period of time and this is an incident which happened every year, means that it must have the better solution than the current solutions, to minimize the risk and the vulnerability for the flood disaster. Theoretically getting the idea of those most important two concepts, flood disaster and the mitigation strategies will help the enhance the knowledge about this most familiar disaster and as well as to overcome this disaster effectively by finding and recognizing the falls of previous mitigation projects in Kaduwela faces this bitter experience every year.

Till 2005 there was a Disaster Management Act, the major document which provided the legal basis as well as, there are number of mitigation projects like, Sri Lanka Multi Hazard Disaster Mitigation Project (SLUMHDMP) in 1997, The Greater Colombo Flood Control and Environmental Improvement Project, after severe flooding of the Capital City of Colombo on 4th June 1992 receiving 493mm of rainfall within 12 hours which is equal tone-eight of the city annual rainfall (Karunaratne 2001) to reduce the damage and risk of this natural disaster, but the people who live in Kaduwela still face this major natural disaster yearly. Empirically the study found out the reasons why flood mitigation projects and strategies not successful and what are the suitable and new strategies that can implement to overcome this disaster.

The stakeholders significance will be immersed from this study can be discussed as follows, the facts which is find through this study will be important to the Ministry of disaster Management specially when the other Authorities (like ministry of Rehabilitation and reconstruction, ministry of Urban Development, ministry of Irrigation, ministry of Defence etc.) are going to implement any project with the help of Disaster Management centre as it can provide the information about flood prone areas, which area damaged by the flood mostly etc. and what are the mitigation strategies, how they implement etc. When it comes to people in the Kaduwela, this will help to prevent and reduce the impact of flood disaster as well as risk and the vulnerability in this urban area.

It will improve the quality of the life in the Kaduwela people and make the way to sustainable life.

## II.METHODOLOGY

The research was conducted using 100 of people as the sample which is selected as per the random sampling method and research strategy taken in this research is survey method as the data collection was done using structured questionnaire method, unstructured interview method and 5 Point Likert Scale method. The research choice is mixed method as the study include of both quantitative and qualitative mechanism.

The independent variables which are structured mitigation strategies (were measured using 5 Point Likert scale method) and non-structured mitigation strategies (were measured using 5 Point Likert scale method) evaluated against the dependent variable which is effectiveness of mitigation strategies in urban development (were measured using structured questionnaire and unstructured interview method).

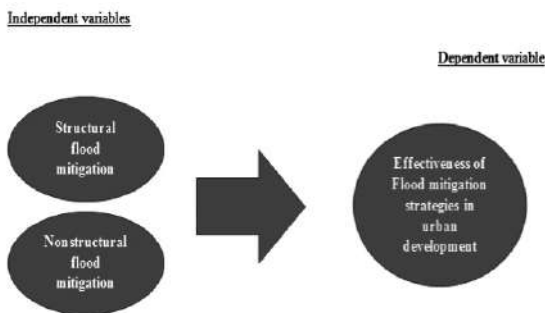


Figure 3. Conceptual framework of the research

Once the conceptual framework was developed the factors which comes under each independent factor was identified through literature. Under these structural mitigation strategies, dams, drainage system, levees and floodwalls, flood barriers and flood gates were identified. Under non-structural mitigation strategies, preparedness, government and regulations, policy institutional mandates and institutional development, flood vulnerability and risk reduction, flood early warning system, land use planning and management and flood proofing and building codes.

Under the sample statistics analysis, such as sample adequacy, sample reliability, goodness of the fitness of the data set and significance of the data set and sample

validity were test using SPSS (version 22). The Kaiser-Meyer-Olkin method was used to test the sapling adequacy of the study. The reliability of the study was analysed through Cronbach’s Alpha model which shows how well the sample data set can generalize and predict the population information was very well adequate. The independent variables were compared with the dependent variable and identified goodness of fit of the model by the Model Fit. ANOVA analysis is used to test whether there is statistically significant difference between dependent variable and independent variables of the sample.

## III. RESULTS

Regarding the sample statistics, the sample adequacy ratio was 0.658 at 0.00 significant levels which is greater than the acceptable value of 0.5 thus the sample is well adequate. According to the sample reliability sample data set can generalize and predict the population information was very well adequate. The independent variables were compared with the relationship between the dependent variable and identified goodness of fit of the model. The R Square value is 0.721 which interprets that the independent variables have 71 precents of effect in change of the dependent variable.

Considering the dependant variable which is the effectiveness of the mitigation strategies in urban development and independent variables which are structural mitigation strategies and non-structural mitigation strategies, it was revealed that there is an effect of structural mitigation strategies and non-structural mitigation strategies over the effectiveness of the mitigation strategies in urban development. Through the data analysis it was revealed.

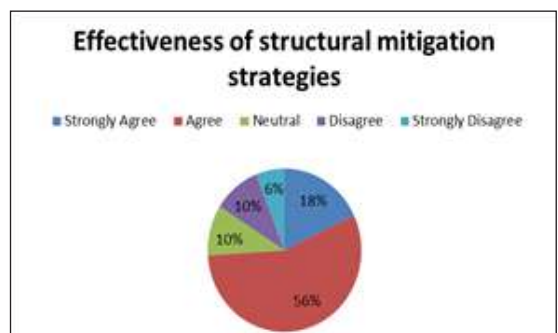
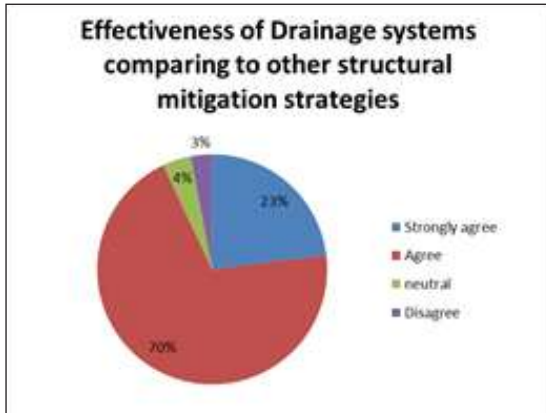


Figure 4: Effectiveness of structural mitigation strategies

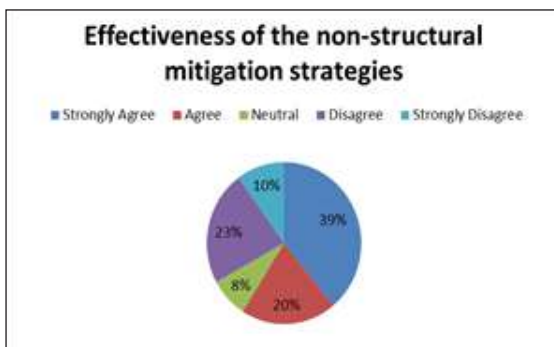
The above figure shows that more than half of the people of the sample agreed that structural mitigation strategies are effective mitigation strategies for urban development.



**Figure 5: Effectiveness of drainage systems**

Under the structural mitigation strategies, drainage systems are the most effective structural mitigation strategy comparing to other structural mitigation strategies which were mentioned in the methodology. The above figure clearly shows it.

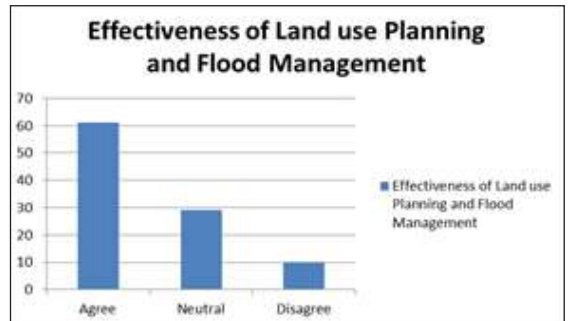
Considering the non-structural mitigation strategies nearly half of the people responded as agree that non-structural mitigation strategies are effective mitigation strategies for urban development.



**Figure 6: Effectiveness of the non-structural mitigation strategies**

Under the non-structural mitigation strategies, land use planning and flood management is the most effective non-structural mitigation strategy comparing to other non-

structural mitigation strategies which were mentioned in the methodology. The below figure shows it clearly.



**Figure 7: Effectiveness of land use planning and flood management**

Comparing structural mitigation strategies and non-structural mitigation strategies out of 100 people sample there were 74% of the people who agreed structural mitigation strategies are effective for urban development and 59% of the people who agreed non-structural mitigation strategies are effective for urban development.

#### IV.DISCUSSION

This study is about Disaster Mitigation Strategies in Urban Development with special reference to the Kaduwela area, regarding the mostly affected flood disaster. The main purpose of this study is to identify the effectiveness of the current flood mitigation strategies in Kaduwela area.

The researcher recognized that there were two independent variables and one dependent variable regarding to this study and they were structural mitigation strategies and non-structural mitigation strategies as independent variables and dependent variable was effectiveness of flood mitigation strategies in urban development.

According to the data analysis with reference to the data collection it was revealed that which areas must be developed further, using structural mitigation strategies as well as non-structural mitigation strategies.

Recommendations are the key factor which revealed the further development of the areas under the areas of, recommendations for communities, authorities and admirations as well as further researchers.

### **A. Recommendations for communities, authorities and admirations.**

An Integrated Post Flood Assessment discovered that the medium-term economic damages to industries and commerce are about ten times higher than that of physical damage. The majority of small-scale entrepreneurs were affected extremely due to absence of in-house capabilities and resources to prepare Disaster Management plans, business continuity plans and recovery plans. Improved co-ordination and facilitation between banks, industries and businesses (especially the SMI sector) could be beneficial. This area may also require introduction of a number of policy interventions at the level of Central Bank and Treasury.

Most of the flood disasters occur because of low addressing of land use planning and flood management. So it is important to provide a science base for addressing land use planning if the people are going to build their construction in flood prone areas. Land use approval processes in local authorities, availability of data for such decision making and better coordination between agencies will help to better land use planning and flood management.

Drainage systems are the most effective structural flood mitigation strategies for urban development and it is not economical to expand the existing drainage systems to accommodate to extreme flood events. Instead, there should be multiple mechanisms that can be put in place to improve drainage (clearing, regular maintenance, etc.), while enhancing the preservation capacity within the premises (constructed wetlands, ponds, buffer storages, rain water harvesting, infiltration improvements etc.).

Though the disasters cannot be avoided or prevented, it is important to be proactive, by providing more accurate and timely weather forecasts and warnings to general public. Most of the disasters can be identified through the Early Warning Systems, as it provides the information about the disaster before it happens. So it is important to improve the Flood Early Warning System to Kaduwela areas who get affected frequently. Most of the people recommended this as an effective flood mitigation strategy. The Sri Lankan government should pay much attention to this with the help of DMC of Sri Lanka.

Most of the disasters happened because of the lack of knowledge of Rules and Regulations. So the government and the relevant authorities must organize programs to improve their knowledge regarding how they behave when

they build constructions in flood prone areas, what are the mitigation strategies that they must address. It is better if the authorized people can visit affected area and share the knowledge with the people as they recommended it with kind heart, and knowledge sharing programs should be attractive and effective for the every person who was in different level of knowledge.

When the researcher visited to most affected areas in Kaduwela, identified that there was lack of constructions and barriers for the flood disaster like flood gates, flood barriers and floodwalls for the relevant areas. So it is responsibility of the government and the DMC to construct flood barriers, floodwalls and flood gates.

### **B. Recommendation for further researches.**

The researcher limited the current research for only one step of the Disaster Management Cycle and that is mitigation, but there are steps Preparedness, Response and Recovery for disasters. As well as the current research limited only for one disaster and that is flood, but there is considerable number of disasters which needed to be addressed. The researcher focused only one area through this current study and that is Kaduwela, but there are areas which vulnerable for the various disasters most of the time like Rathnapura (flood), Badulla (landslides), hambanthota and Monaragala (drought) etc.

## **V. CONCLUSION**

Disaster mitigation is vast area to study and it is important to study this subject as it helps to the sustainable development of the county, reducing the vulnerability of disasters. As a country the government and the related authorities like Disaster Management Centre, Red Cross and NGOs should be aware of the mitigation strategies for every disaster. Considering the disasters the most affected disaster is flood and it is important to study the mitigation strategies of flood disaster. So this current study focused on the flood mitigation strategies in urban development with special reference to the Kaduwela area.

The researcher recognized the current mitigation strategies for flood disaster as structural mitigation strategies and non-structural mitigation strategies which were the independent variables in the conceptual framework. As well as based on the secondary objectives the researcher identified why Kaduwela area still got affected by the flood disaster heavily if there were flood mitigation strategies.

Through the recommendations of the people the researcher identified what are the most effective and what are the useful strategies that were not in the field.

#### ACKNOWLEDGMENT

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As well as I would like to thank all the people who were supported me by giving the valuable time to fill my questionnaire and provide answers, Director and other respective people of Disaster Management centre, Director and other respective people of Kaduwela Municipal Council and Grama Niladari who spent their time for give the information and share the experiences.

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# A STUDY ON THE FACTORS INFLUENCING THE USE OF e-COMMERCE BY CUSTOMERS IN COLOMBO WITH RESPECT TO B2C MARKET

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**Abstract** - This study explores the factors influencing the use of e-commerce by the customers in Colombo district with regard to the B2C market. The conceptual framework was designed based on the Theory of Planned Behaviour (TPB) and 24 potentially influential factors were explored throughout the study. Primary data were collected by means of a questionnaire given in internet based and printed formats where the respondents were received from both users and non-users of online purchasing in the Colombo district of Sri Lanka. 354 valid questionnaires were used in the analysis and the Cronbach's Alpha was 0.719 in the reliability test. A proper and well explained descriptive analysis of the variables followed by the KMO and Bartlett's test, Hypothesis testing, Factor analysis and an advanced model fitting was carried out. Analysis revealed that there is a very positive opinion towards online purchasing and people do have the willingness towards it. In view of the above and the model developed, it was found that attitudinal factors have a profound effect while subjective norm and perceived behavioural control shows a superficial effect on the online purchasing intention. Based on the inferences from research findings, recommendations and strategic and managerial suggestions were also made.

**Keywords** - Online purchase intention, Theory of Planned Behaviour, Decomposed Theory of Planned Behaviour, e-commerce

## I. INTRODUCTION

With the advancement of technology, people have been able to fulfil most of their activities just away from a click of a button. Any field of work or industry you name, technology has played, is playing and, will play its part

in order to facilitate the corresponding field or industry a user friendly, simplified and a value adding service in every aspect possible. Agriculture, Health & Safety, Finance, Education, Security, Construction, Communication and, Supply Chain can be identified as some of the industries significantly expedited with technology.

In order to sustain, people have to fulfil their needs and wants. To achieve these, they will have to find the sources of supply of these requirements. With the passing of time and the development of trade, different suppliers and manufacturers immersed where people could accomplish their purchasing requirement of goods and services from them. In a typical scenario, a customer will reach a retail outlet or a store proximate and purchase the product/s he/she wants. The aforesaid technology has made a turning point in purchasing where at present a lot of online platforms have come to stage which has made these activities far more easy, simple and efficient in the meantime. With the help of these ecommerce platforms, the customers have been able to do their purchasing online via internet without purchasing in-person. This has made drastic changes in supply chain where at some point it could be perceived as an advantage whereas at some point it is not. Electronic Commerce also referred to e-commerce is one aspect that has emerged with the aid of technology where it can be identified as a business module or as a part of a large business entity which empowers a firm or an individual to carryout business activities over an electronic network; internet. Simply, e-commerce is the use of internet to carry out business or rather commercial activities such as online purchasing and subsequent functions. The Operation of ecommerce can be identified in major market segments/business model namely, Business to Business (B2B), Business to Consumer (B2C),



Consumer to Consumer (C2C) and, Consumer to Business (C2B). Business to consumer (B2C) is a business or transactions conducted directly between a company and consumers who are the end-users of its products or services. However, the rise of the internet has created an entire new B2C business channel in the form of e-commerce or selling goods and services over the internet.

## II. METHODOLOGY AND EXPERIMENTAL DESIGN

A collection of literature are refereed in order to identify the experimental design for the study. Reliability test, descriptive statistics, chi-square test for independences, Factor analysis, KMO & Bartlett’s test and Regression Linear Models are used for the analytical purposes.

### A. Technology Acceptance Model

As per Davis, (1989) a theoretical model was developed to explain and predict the user behaviour of information technology where the researcher has built a relationship between two main determinants of technology acceptance identified as, Perceived Usefulness (PU) and perceived Ease of Use (EOU).

#### 1) Perceived Usefulness (PU)

As defined by Davis, (1989) PU is “the degree to which a person believes that using a particular system would enhance his or her job performance”. This can be simply identified as the aspects where people tend to use or not use an application to the extent that they believe that it will help them to perform their work better. This follows from the definition of the word useful: “capable of being used advantageously”.

#### 2) Perceived Ease of Use (PEU)

In contrast with perceived usefulness, perceived ease of use refers to “the degree to which a person believes that using a particular system would be free of effort”. This follows from the definition of the word ease: “freedom of difficulty or great effort”.

### B. Theory of Planned Behaviour

The researchers Teo, (2001); Vijayasathy, (2003); Wu, (2003); Chang, (2008); Laohapensang, (2009) and Chiu, (2005) has used the Theory of Planned Behaviour (TPB)

in order to explain and predict consumer online shopping attitude, intention and behaviour. Chang M. K., (2005) had observed six studies of attitude toward online shopping and all of these studies has shown that attitude toward online shopping shows a significant positive impact on online shopping intention and behaviour.

### C. Decomposed Theory of Planned Behaviour

Taylor, (1995) introduced the idea that TPB beliefs can be decomposed into multidimensional constructs where attitude, subjective norm and perceived control behavioural beliefs are decomposed as illustrated below.

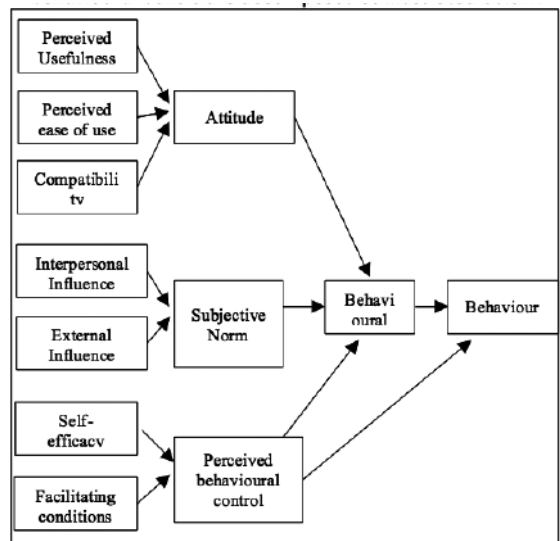


Figure 1. Decomposed Theory of Planned Behaviour

### D. Sampling

Simple random sampling method is used as the sampling method of the research. Simple random sampling is a randomized process without any favoured treatment where each element in the population has got an equal probability of being selected to the sample (Sample of n from N population).

Simple random sampling is accepted due to this characteristic, as well as, it is suitable to a population which is very much larger than the sample.

Colombo district is selected based on the fact that Colombo province comprises the highest population (2012) among all districts (Economic and Social Statistics of Sri Lanka.,

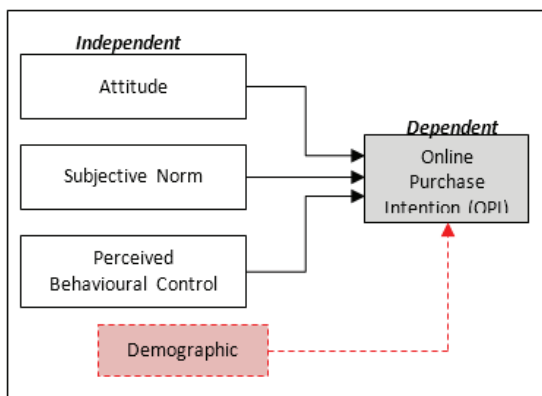
2014) and that people in the Colombo district represents a homogenous group with similar lifestyles where given that, Department of Census and Statistics states that Colombo district has the highest population of internet users and a high literacy rate of 27.6% and 47.1% respectively.

**E. Data Collection**

A combination of a physical paper-based questionnaire and an internet-based questionnaire were used in data collection. Internet-based questionnaire was developed using Google Forms and mailed to accessible e-mail addresses. Social network sites were also utilized to distribute the questionnaire via the internet. The questionnaire was distributed to 420 in total, concerning the time constraint of the study. Considering both modes, a total of 362 responses were received out of which eight respondents were rejected due to partial completion of the questionnaire. Hence the number of complete respondents were 354 which accounted for a complete response rate of 84.28%.

**F. Conceptual Framework**

The conceptual framework is built primarily on the theories of planned behaviour and the decomposed theory of planned behaviour. Accordingly, the independent variables which are Attitude, Subjective Norm and Perceived Behaviour Control will be further divided with reference to the decomposed theory of



**Figure 2. Conceptual Framework**

planned behaviour along with the demographic factors. The dependent variable is identified as the Online Purchase Intention (OPI).

**III. ANALYSIS**

A Cronbach Alpha value of 0.719 for 35 items was achieved and it interprets the reliability of the questionnaire used in data collection.

A descriptive analysis is done on the demographic variables including age, gender, education, sector of employment, income level, etc. It is identified through the feedback that there exists a high overall online purchasing intention of 81% or 286 respondents out of 354 respondent sample whereas, 19% or 68 respondents have a low overall online purchasing intention. This implies the overall willingness of the respondents to engage in online purchasing.

**A. Bivariate Analysis**

The bivariate analysis has delivered a variation of measures in a two-way table as interpreted by an example below.

**Table 1. Online purchasing intention vs. Save time**

		Save time			Total
		Neutral	Agree	Strongly agree	
Online purchasing intention	Low	14 20.6%	43 63.2%	11 16.2%	68 100.0%
	High	39 13.6%	169 59.1%	78 27.3%	286 100.0%
Total		53 15.0%	212 59.9%	89 25.1%	354 100.0%

Out of the respondents who have a low overall online purchasing intention, 63.2% have agreed to that online purchasing saves time while 20.6% and 16.2% hold neutral and strong agree upon the fact.

On the other hand, it is evident that, 59.1% of the respondents who claims to be having a high online purchase intention have agree on the fact that online purchasing saves time. Therefore collectively, a total of 86.4% of the respondents with a high overall willingness to purchase online have positive views towards the fact that online purchasing saves time.

**B. Chi-Square Test**

With the results of cross tabulation (bivariate analysis), hypothesis testing has been carried out using Chi-square test to check the relationship between the online purchasing intention and other variables concerned. The Hypothesis testing is as follows,

H0: Online purchasing intention is independent from the ith variable

H1: Online purchasing intention is dependent on the ith variable

**Table 2. Chi-Square Test for the ith variable**

Variable (i <sup>th</sup> ) Name	Test statistic	P value	Significance
Influence of family	96.781	0.000	Significant
Cheaper	82.221	0.000	Significant
Like online purchasing than stores	77.108	0.000	Significant
Influence of friends	69.653	0.000	Significant
Can wait till delivered	53.954	0.000	Significant
Different payment terms	44.82	0.000	Significant
Have time	44.609	0.000	Significant
Not seeing the product	43.438	0.000	Significant
Influence of mass media	34.911	0.000	Significant
Can purchase online on own	33.288	0.000	Significant
Willing to pay online	32.694	0.000	Significant
Ease of getting skilled	29.587	0.000	Significant
Have money	25.519	0.000	Significant
Delivery fee	18.987	0.001	Significant
Reliable delivery	15.394	0.002	Significant
Delivery time	15.212	0.004	Significant
Save time	4.621	0.099	Insignificant
Comparison shopping	2.912	0.405	Insignificant
Positive views	1.865	0.000	Significant
Fits the lifestyle	1.422	0.000	Significant
Feel comfortable	1.394	0.000	Significant
Ease of learning to operate	1.275	0.000	Significant
Fits the purchasing need	1.124	0.000	Significant

**C. Factor Analysis**

**1) KMO and Bartlett's Test:**

**Table 3. KMO and Bartlett's Test:**

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.679
Bartlett's Test of Sphericity	Approx. Chi-Square	4.166E3
	df	276
	Sig.	.000

As KMO test statistic is 0.679 which is greater than 0.6, it can be concluded that sample size is adequate for a factor analysis to be proceed. The two hypothesis which are tested in the KMO and Bartlett's test are as follows.

Ho: There does not exist any correlations among the variables

H1: There exists correlations among the variables

As p-value of the Bartlett's test is 0.000, null hypothesis is rejected. Hence, it can be concluded that, correlation matrix is not an identity matrix which further supports the strength of the relationship among variables used in factor analysis.

**2) Total Variance Explained:**

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.990	24.957	24.957	5.990	24.957	24.957	3.298	13.740	13.740
2	2.276	9.484	34.441	2.276	9.484	34.441	3.238	13.490	27.231
3	2.167	9.028	43.469	2.167	9.028	43.469	2.204	9.184	36.415
4	1.920	8.000	51.469	1.920	8.000	51.469	1.843	7.680	44.095
5	1.339	5.580	57.048	1.339	5.580	57.048	1.810	7.540	51.635
6	1.310	5.457	62.506	1.310	5.457	62.506	1.700	7.084	58.719
7	1.167	4.861	67.367	1.167	4.861	67.367	1.633	6.805	65.524
8	1.085	4.520	71.887	1.085	4.520	71.887	1.527	6.363	71.887
9	.904	3.766	75.653						
10	.832	3.465	79.118						
11	.761	3.171	82.289						
12	.695	2.898	85.187						
13	.574	2.393	87.580						
14	.536	2.235	89.815						
15	.410	1.708	91.523						

**Figure 3. Total Variance Explained**

As per the Figure 3 shown above, we can observe the initial Eigen values which are greater than one. It can be observed that the first eight components carry Eigen values which are greater than one where we can select these eight components. In addition to that, the first component

identified above, accounts for 24.957% of the variance while the second, third and the fourth components accounts for 9.484%, 9.028% and 8.000% respectively. The eight factors identified above has explained 72% of the total variance explained collectively.

3) Scree Plot:

The scree plot helps to determine how many factors to be retain. It can be seen that the curve begins to flatten between the component eight and component nine. Therefore it further elaborates that only eight components can be retained.

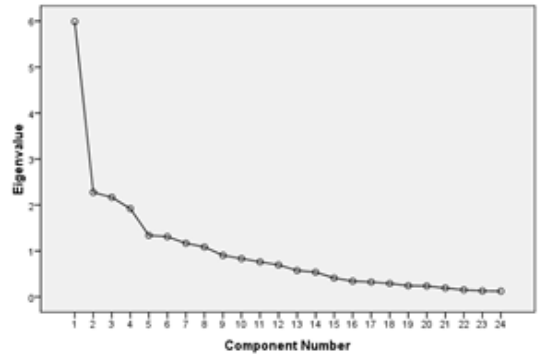


Figure 4. Scree plot for the variables

Table 4. Rotated Component Matrix of variable

	Component							
	1	2	3	4	5	6	7	8
Save time	.150	<b>.432</b>	-.588	.089	.065	.185	-.040	-.374
Allows comparison shopping	-.340	<b>.543</b>	-.032	.526	-.064	-.234	.128	-.014
Purchasing online is cheaper	.147	.189	.232	<b>.820</b>	.100	.082	-.066	.020
Can enjoy different payment terms	.123	.108	-.065	.057	.003	.292	<b>.648</b>	.332
Ease of learning to operate	<b>.681</b>	.298	.073	-.358	.120	.095	.045	.115
Ease of getting skilled	.368	<b>.440</b>	.166	-.608	.126	.061	-.051	-.066
Fits the purchasing need	.482	<b>.528</b>	-.057	.022	.395	-.041	.215	-.111
Fits the lifestyle	<b>.759</b>	.281	-.076	.051	.265	.134	.103	.054
Reasonable delivery time	-.086	<b>.469</b>	.346	-.255	.123	.436	-.070	-.355
Low delivery fee	.178	-.031	<b>.744</b>	.123	.004	.016	-.249	.083
Like online purchasing than in stores	.297	.259	.255	-.257	.316	<b>.431</b>	.358	-.249
Can wait till delivered	.196	.005	.005	.015	.145	<b>.877</b>	-.106	-.019
Reliable delivery	-.066	.070	-.088	.033	<b>.813</b>	.157	.200	.035
Not seeing the product is not a risk	.007	-.037	-.015	-.020	.110	-.287	<b>.804</b>	-.158
Willing to pay online	.392	.286	.121	-.047	<b>.682</b>	.004	-.206	-.049
Influence of family	.160	.199	<b>.792</b>	.063	-.034	.104	.168	-.005
Influence of friends	<b>.632</b>	.130	.416	-.127	.073	.195	-.068	.052
Have seen/read positive views on online purchasing	<b>.793</b>	.023	.223	.155	-.204	.094	.071	-.115
Influence of mass media	.273	<b>.405</b>	.103	.271	-.244	.389	.156	.160
Feel comfortable in purchasing online	.242	<b>.703</b>	.314	.075	.217	.138	.031	-.034
Can purchase online on own	.115	<b>.628</b>	-.043	.085	.108	.008	.053	.292
Have time to purchase online	.227	<b>.725</b>	-.037	-.080	.032	.066	-.038	.126
Have money to purchase online	-.061	.224	.181	.067	.043	-.016	-.044	<b>.808</b>
Have equipment to purchase online	.369	.088	-.023	-.300	-.300	-.038	.353	<b>.473</b>
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.								
a. Rotation converged in 15 iterations.								

**D. Rotated Component Matrix**

The main purpose of factor rotation is to minimize number of factors on which the variables under investigation have high loadings. Meaningful factors can be obtained by rotating factors. Specially, Varimax Rotation method is used in this study.

As shown in the Rotated Component Matrix table shown in Table 4.30 above, rotation has reduce the number of factors on which the variables under investigation have high loadings which makes the interpretation of the analysis easier. According to the rotated factor loadings, 24 variables can be categorized for extracting eight factors. The eight factors are identified as below.

- Factor 01 – Influence and Convenience
- Factor 02 – Ability and Advantageousness
- Factor 03 – Delivery and Influence
- Factor 04 – Cheap
- Factor 05 – Reliability
- Factor 06 – Preference
- Factor 07 – Risk Freeness
- Factor 08 - Availability

Reliability of the factors are tested for and the first two factors are found to be reliable with 0.800 and 0.758 values of Cronbach Alpha.

**E. Factor 01 – Influence and Convenience**

Under factor 01, which is “Influence and reliability”, the following key areas are taken in to discussion.

- Reliability
- Correlation
- Advanced Model Fitting

**1) Reliability:** The reliability of the variables affecting to influence and convenience (Factor 01) were checked and a Cronbach’s alpha value of 0.800 was obtained. Hence this factor is used for further analysis.

**2) Correlation:**

$H_0$ : Influence and convenience (Factor 01) is independent from the ith variable

$H_1$ : Influence and convenience (Factor 01) is dependent on the ith variable

Influence and convenience (Factor 01) is dependent on the

below mentioned variables under five percent level.

- Age
- Gender
- Education
- Employment
- Income
- How often purchased online
- What is mostly purchased online

**3) Advanced Model Fitting**

Omnibus Test for Factor 01 is tested and a significance value of 0.000 is obtained which is less than 0.05. Hence the current model outperforms the null model.

The parameter estimates of “Influence and Convenience” were identified and the below mentioned fitted model was built up in conclusion.

$$\begin{aligned} \text{Influence and convenience} = & 18.709 + 0.255(\text{age}_1) + \\ & 2.033(\text{age}_2) + 3.069(\text{age}_3) + 1.346(\text{age}_4) + \\ & 1.304(\text{age}_5) - 1.824(\text{sex}_2) + 11.836(\text{edu}_1) + \\ & 9.808(\text{edu}_2) + 8.660(\text{edu}_3) + 3.473(\text{edu}_4) - \\ & 9.165(\text{emp}_1) - 9.290(\text{emp}_2) - 6.979(\text{emp}_3) - \\ & 11.209(\text{emp}_4) - 7.743(\text{emp}_5) - 3.158(\text{income}_1) - \\ & 4.291(\text{income}_2) - 5.280(\text{income}_3) - 9.765(\text{income}_4) - \\ & 6.811(\text{income}_5) - 0.083(\text{how.often}_1) \\ & + 1.673(\text{how.often}_2) + 2.926(\text{how.often}_3) + \\ & 4.861(\text{how.often}_4) - 5.322(\text{what}_1) - 2.591(\text{what}_2) - \\ & 2.486(\text{what}_3) - 2.625(\text{what}_4) \end{aligned}$$

The variables used above in the model are identified as bellow.

**Table 5. Interpretation of the variables**

age_1	Below 18	emp_5	Retired
age_2	18 – 25	income_1	Below 20,000
age_3	26 – 35	income_2	20,001 – 40,000
age_4	36 – 45	income_3	40,001 – 60,000
age_5	46 – 55	income_4	60,001 – 80,000
sex_2	Female	income_5	80,001 – 100,000
edu_1	O/L	how.often_1	Never
edu_2	A/L	how.often_2	A couple times a year
edu_3	Degree	how.often_3	Monthly
edu_4	Masters	how.often_4	Weekly
emp_1	Student	what_1	Books
emp_2	Private Sector	what_2	Clothing/Footwear
emp_3	Public Sector	what_3	Jewellery/Accessories
emp_4	Business	what_4	Electrical Appliances

As per the above developed model, Compared to a person whose age is above 55 years,

- A person in the age category of 46 – 55 years makes the person 1.304 times more likely to be influenced and convenient in using online shopping.
- A person who is in the age category of 36 – 45 years makes that person 1.346 times more likely to be influenced and convenient on using online shopping.
- A person in the age category of 26 - 35 is 3.069 times more likely to be influenced and convenient towards the use of online shopping.
- A person in the age category of 18 – 25 years makes the person 2.033 times more likely to be influenced and convenient in using online shopping.
- A person in the age category below 18 is 0.255 times more likely to be influenced and convenient to engage in online shopping than of the person above 55 years of age.

Similarly, the parameter estimates of “Ability and Advantageousness” were identified and the subsequent fitted model was built.

## IV. DISCUSSION AND CONCLUSION

### 1) Discussion on the demographic profile and preferences:

It is observed that 81% of the respondents have a high overall willingness towards the use of e-commerce or rather engage in online purchasing where only 19% has a low overall willingness. 354 valid questionnaires were used in the analysis with a Cronbach's Alpha value of 0.719 in the reliability test. This suggests that the internal uniformity of the research instrument is good and has succeeded the required thresholds. The demographic attributes in respect of the overall intention for online purchasing is stated below.

Age can be considered as an important parameter in studying the willingness for online purchasing. As per the analysis carried out in chapter four, respondents in the age group of 18 – 25 accounts for a 47.2% of the respondents. It was observed that 86.7% of the respondents in this age

category have a high online purchasing intention. The second highest age group below the age of 18 and 100% of the respondents below the age group of 18 have a high online purchasing intention. Next comes the age categories above 55, 36 – 45, 26 – 35 and 45 – 55 where the overall online purchasing intentions of these age categories being high were identified to be 15.2%, 80.8%, 76.0% and 53.8%. Hence it implies that population below the age of 45 is more likely to have a high overall online purchasing willingness/intention.

When the gender is taken in to consideration, out of the total male respondents, 78.1% have a high online purchasing intention while for females, it is 85.4% of the total female respondents. Therefore it shows a slight tendency of the females to have a higher online purchasing intention than the males.

The level of education can be also be considered here, where 100% of the respondents having done the O/Ls have a high online purchasing intention and so were the 93.5% of the respondents with the A/L qualification. It was evident that 78.2% of the respondents with a degree level education qualification, possess a high online purchasing intention. Respondents with masters and doctorates are less likely to be engaged in online purchasing.

The area of employment cannot be identified as a significant factor where unless retired, all the respondents do have a tendency towards online purchasing.

Once the type of goods most purchased online by the customers is concerned, it was identified by the study that expect for books, a majority of the respondents have an interest in buying footwear/clothing, jewellery/accessories, electrical appliances and electronic items online. This implies that the online store service providers have a great opportunity in a variety of goods.

As per the above findings, discussions and recommendations can be done in two perspectives which are from the perspective of the customer and the service provider.

### Service Providers'/ Business Perspective

- Service providers could consider to focus more on the age category below 45 years of age since this age category in the sample consists respondents with high online purchasing intention.

- There is a slight tendency of the females to be more influenced towards the use of online purchasing than men.
- E-commerce or rather online purchasing is more commonly influenced with the level of income an individual received. Higher the salary, higher the overall willingness towards the use of online purchasing.
- A majority of the sample with high online purchasing intention agree to that online purchasing allows comparison shopping. Hence, it would be ideal for the service providers to study the online market and have a strategic pricing policy to have competitive advantage.
- 39.5% of the respondents with high online purchasing intention have neutral views on the fitness of online purchasing to the customer needs. Therefore the service provider could consider doing a market research and a study on the customers to improve the fitness of the online goods available as per the customer requirement.
- Both respondents with high and low online purchasing intention have a neutral perception on the fact that the delivery fees of online purchased items are low. Hence, the online purchasing service providers could consider taking this as an opportunity to convert this population to active users of online purchasing.
- It was evident that the sample respondents have a negative perception towards the reliability of the delivery once purchased online. Therefore, the service providers could try to change this perception in the customers' mind and convert this population to a target market.

### Customers' Perspective

- Through the findings of the research, it was observed that attitudinal variables have a profound effect while subjective norm and perceived behavioural control do not show a superficial effect on the online purchasing intention.
- Attitudinal variables which were found to have significant impact include the below mentioned,
  1. Save time
  2. Comparison shopping
  3. Ease of getting skilled to engage in online purchasing
  4. Fitness for the purchasing need
  5. Reasonable delivery time
  6. Ease of learning to engage in online shopping
  7. Fitness for the purchasing need
- A majority of the respondents/customers have said that they mostly purchase clothing and footwear items online where, as the second highest comes jewelry and accessories.

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# ANALYSIS OF THE IMPACT OF GREEN PRACTICES ON THE PERFORMANCE OF LARGE SCALE APPAREL INDUSTRY OF SRI LANKA

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**Abstract** - This research has been conducted to analyze the impact of green practices on the performance of large scaled apparel industry. People are increasingly concerned with the social responsibility and business ethics while doing businesses. Suppliers prefer companies that have good ethical practices where green logistics is one of the major priorities. Consumers are also increasingly more aware and concerned with global issues, which results in greater demand for eco-friendly or green goods and services.

The objective of the study was to analyze the impact of green practices in the performance of large scale apparel industry of Sri Lanka. Study covers the production lines that are enlisted with the Sri Lankan Board of Investment, which principally accumulates substantial scale organizations in the garment sector.

The sample is 30 large scale garment factories. Judgemental sampling was used to select the major apparel manufacturers. Interviews as well as questionnaire survey method were used for data collection. The study discovers most of the plants overviewed deliberately actualized no less than one natural management practice which affects positively, for example, water re-use, material re-use and ecological reviews, reduction in the carbon footprinted, solar power usage. Employees have a more favourable view on companies that have environmentally friendly practices.

Today businesses focus more on quality management to grab customer interest via inculcating rich corporate social responsibilities which is the main concern of the consumers, suppliers, employees, government

and environmental activists. This concept of green manufacturing has become a key strategy for companies in generating competitive advantage and sustainability to achieve the organizational goals and objectives.

**Keywords** - Green practices, Environmental impact, Water usage, Energy usage, Carbon footprint

## I. INTRODUCTION

Consumers in the current business world, who are the final users of clothing made in countries like Sri Lanka, are becoming more aware of environmental impacts from industries and thus companies are feeling the pressure to be more environmentally conscious in their manufacturing (Cai & Li, 2008). At present, most of the fabric companies focus on going green due to increasing concerns about adverse environmental impacts from industries, particularly global warming.

Though a few number of research have been done in the apparel industry, it is a timely requirement to conduct a research since there is a research gap on this area as the impact of green practices on the operational performance Sri Lankan large scale apparel industries has not been focused on much.

The major environmental impacts associated with the production and use of apparel throughout its life cycle include wastewater emissions from dyeing, finishing, washing processes, increase in pollution, solid waste production, significant depletion of resources from consumption of water, fossil fuels, and raw materials

(Islam, 2013). Chemicals are also released in wastewater from processes such as pre-treatments, dyeing, finishing, and laundry. The objective of the study was to analyze the impact of green practices on the performance of large scale apparel industry of Sri Lanka.

## II. LITERATURE REVIEW

The life span of the businesses is depending upon the feasibility towards the environment. This can be observed in terms of which natural resources the production process might need, how resources are used and recharged, the overall influence of the end production on the environment and where the product ends up resulting its disposal (Islam & Rahman, 2014).

Total value of export earnings in the sector was at US dollars 2,424 million accounting for 52 % of the total export earnings in 2002. The contribution to the Gross Domestic Product (GDP) was 5.3% in 2002. This industry has delivered more than 330,000 direct employment or 5% of country's total employment in more than 1,060 garment factories (Dheerasinghe, 2003) The industry has enjoyed an enormous growth level over the past four decades and is today Sri Lanka's primary foreign exchange earner accounting to 40% of the total exports and 52% of industrial products exports (Central Bank of Sri Lanka, 2015).

The most noteworthy industry in Sri Lanka is the clothing industry. It has been mounting within the last 3 decades and has become the number one foreign exchange earner. It has reduced water consumption by 70% along with 50% of the electricity consumption. With reduced overheads, fast return on investments and through the practice of lean manufacturing these factories have found their business sustainability (Export development board, n.d.).

Through building green factories top companies in Sri Lanka have taken ingenuities to make their manufacturing process sustainable. By doing so they have succeeded with environment credentials such as certifications and titles as a part of company's ethical trading.

Outsized organizations started using green practices from their ground level manufacturing itself as a marketing strategy for their patrons to go beyond their competitors to show the corporate, social and environmental responsibilities they take as a company.

Except for a few organizations the degree of commitment of the ground level manufacturing has changed acceptably (Thilakarathna & De Silva, 2014). The frequency of environmentally responsible practices carried out by the organizations will momentarily receive an enhancement from the International Organization of Standardization. ISO 14000, a registration process for vendors similar to the ISO 9000 series, will specifically target ecological procedures universal (Wu & Dunn, n.d.).

Green industry in the textile sector will integrate different methodologies in numerous ways in order to maximize the level of benefit they incur.

This will also generate a very good environment for the efficiency and productivity of employees where the industries have taken better mechanisms to generate a successful and an effective working environment for the employees. There are a lot of measures taken namely, temperature reduction passively in the green factory by using cool roof (off white color coated Zinc and aluminum roofing sheet), photovoltaic roofs (solar panels) and green roofs (concrete roof with vegetation on top) (Thilakarathna & De Silva, 2014).

Sri Lanka suppliers and manufacturers have taken a cooperative effort in order to reduce the carbon footprint to make the local apparel industry more eco-friendly and sustainable (Export development board, n.d.) Additionally the green factory is powered by carbon-neutral sources, but most factories get power from the main grid and diesel generators. Further it saves 50% of the potable water consumed by an equivalent normal factory (Thilakarathna & De Silva, 2014). Green factory uses push taps, low flow plumbing fixtures and many other things to save water, rain water harvesting tanks are constructed on top of toilets which send water down for flushing under gravity flow. For purifying the air, to diminish soil erosion and to preserve water, green factories have planted native trees.

Thus green factory helps preserve the natural environment and ecosystems healthy for humans, animals and plants by reducing waste and greenhouse gas emissions, controlling pollution and treating land, air and water as precious resources (Thilakarathna & De Silva, 2014) For industries with lower margins, such as the clothing industry, green supply chain management can move towards reduction in supply chain related costs. These cost decreases can be lead into substantial competitive advantages and profit (Eryuruk, n.d.).

The sustainable construction movement is now universal

in scope, with almost 60 national green building councils establishing determined performance goals for the built environment in their countries (Charles, 2012). The concept of Green building is an all-inclusive start with the understanding that the constructed environment can have thoughtful effects, both plus and minus but mostly positive, on the natural environment, as well as the people who reside buildings every day (Kriss, 2014). Green factory has helped the employees to reduce their absenteeism rate and remaining in the factory.

The average absenteeism rate in green factory and non-green factory were 3.07% and 4.38% respectively. Therefore, we can see a clear difference. Green building is a struggle to strengthen the positive effects and alleviate the negative effects throughout the entire life cycle of a building. By adjusting energy performance, reducing emissions, reducing waste, encountering recycling, reducing sediment contamination and soil water erosion green factory achieves environment sustainability.

The factory's land area is left to nature, covered with greenery or water and managed as a habitat for plants and animals to make the environment pleasing and to make the factory more eco-friendly (Thilakarathna & De Silva, 2014).

### III. METHODOLOGY

The impact of green practices on the performance of the large scaled apparel industry is considered as the dependant variable of this study. Reducing Energy usage, Reducing Carbon usage, Reducing Water usage and Reducing the environmental impact are the independent variables considered.

The study was based on primary data collection. To obtain the primary data, a questionnaire was designed consisting of the factors obtained through an extensive literature review. Thereafter a questionnaire survey was conducted. The questionnaire was distributed among the factories that are practicing green practices. The Likert scale with five options was used to capture the responses in the questionnaire. 30 large scaled apparel manufacturers in Sri Lanka who are engaged in green practices were the sample considered for the study.

Judgemental sampling was used in order to select the major apparel manufacturers. Interviews as well as questionnaire survey method were used for data collection. The

conceptual framework depicted in Figure 1 was developed based on previous literature and factors identified.

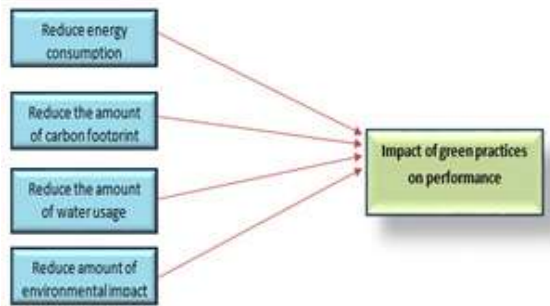


Figure 1: Conceptual Framework

During the analysis, the Kaiser–Meyer–Olkin (KMO) test was used to test the sampling adequacy of the study. The reliability of the sample was analysed through Cronbach’s Alpha value which evaluates the internal consistency within the variables of the study. Descriptive statistics and Correlation analysis were used as the main data analysis methods. SPSS was the software used for the data analysis.

### IV. RESULTS

The collected data was entered into SPSS 22.0 which can be identified as a statistical software tool.

Table 1: Test of Reliability using the Cronchbach Alpha value

Cronbach's Alpha	N of Items
.980	5

Table 2: KMO test value

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.806
Bartlett's Test of Sphericity	Approx. Chi-Square	169.652
	Df	6
	Sig.	.000

As in Table 2 the KMO value obtained is 0.806 which is greater than the acceptable value of 0.5, therefore this ensures the sampling adequacy of the study.

The Cronbach's Alpha value is 0.980, as in Table 1, which is greater than the acceptable value of 0.7, therefore the internal consistency is depicted.

**Table 3: Correlations- Reduction in energy usage and organizational performance**

		Energy	Impact of green practices on org. perf.
Kendall's tau b	Reducing Energy usage	1.000	.808**
	Impact of green practices	.808**	1.000
Spearman's rho	Reducing Energy usage	1.000	.916**
	Impact on org. perf.	.916**	1.000

\*\* Correlation is significant at the 0.01 level (2-tailed).

As per Table 3 Kendall's tau\_b the reduction of the energy usage and the impact of green practices on the organizational performance are positively related assuming other factors (environmental impact, water usage reduction, carbon footprint reduction) remains constant.

Since the correlation coefficient which is 0.808 represents that the correlation is strong. As per Spearman's rho reduction of the energy usage and organizational performance are positively and strongly correlated (correlation coefficient which is 0.916) Therefore, there is a strong positive correlation between reduction of energy usage and the impact on organizational performance.

**Table 4: Correlation-Reduction in the amount of carbon footprint and the organizational performance**

		Reducing Carbon usage	Impact on org. perf.
Kendall's tau b	Reducing Carbon footprint	1.000	.819**
	Impact on org. perf.	.819**	1.000
Spearman's rho	Reducing Carbon footprint	1.000	.931**
	Impact on org. perf.	.931**	1.000

\*\* Correlation is significant at the 0.01 level (2-tailed).

As per As per Table 4 Kendall's tau\_b the reduction of the carbon footprint amount and the impact of green practices on the organizational performance are positively related.

The correlation coefficient which is 0.819 represents that the variables have a strong positive relationship.

As per Spearman's rho reduction of the carbon footprint amount and the impact of green practices on the organizational performance are positively.

The correlation coefficient is 0.931 and there is a strong positive correlation between the reduction of carbon footprint amount and the impact on performance.

**Table 5: Correlations-Reduction in the amount of water usage and impact on the organizational performance**

			Reducing Water usage	Impact on org. perf.
Kendall's <u>tau_b</u>	Reducing Water usage	Correlation Coefficient	1.000	.723**
		Sig. (2-tailed)	.	.000
		N	30	30
	Impact on org. perf.	Correlation Coefficient	.723*	1.000
		Sig. (2-tailed)	.000	.
		N	30	30
Spearman's rho	Reducing Water usage	Correlation Coefficient	1.000	.864**
		Sig. (2-tailed)	.	.000
		N	30	30
	Impact on org. perf.	Correlation Coefficient	.864*	1.000
		Sig. (2-tailed)	.000	.
		N	30	30

\*\* . Correlation is significant at the 0.01 level (2-tailed).

As per Table 5 Kendall's tau\_b the reduction of the amount of water usage and the impact on organizational performance are positively related. Since the correlation coefficient is 0.723 it represents that the correlation is significant.

As per Spearman's rho reduction of the amount of water usage and the impact on organizational performance are positively related. Since the correlation coefficient is 0.864 the correlation is significant.

There is a strong positive correlation between reduction of water usage and the impact on organizational performance.

**Table 6: Correlations - Reducing the environmental impact and the organizational performance**

			Reducing the environmental impact	Impact on org. perf.
Kendall's <u>tau_b</u>	Reducing the environmental impact	Correlation Coefficient	1.000	.830**
		Sig. (2-tailed)	.	.000
		N	30	30
	Impact on org. perf.	Correlation Coefficient	.830**	1.000
		Sig. (2-tailed)	.000	.
		N	30	30
Spearman's rho	Reducing the environmental impact	Correlation Coefficient	1.000	.936**
		Sig. (2-tailed)	.	.000
		N	30	30
	Impact on org. perf.	Correlation Coefficient	.936**	1.000
		Sig. (2-tailed)	.000	.
		N	30	30

\*\* . Correlation is significant at the 0.01 level (2-tailed).

As per Table 4.4 Kendall's tau\_b reducing the environmental impact and the impact of green practices on the organizational performance are positively related. Since the correlation coefficient is 0.830 the correlation is significant.

As per Spearman's rho, reducing the environmental impact and the impact on the organizational performance are positively related. Since the correlation coefficient is 0.936 the correlation is significant. There is a strong positive correlation between reduction of the environmental impact and organizational performance.

## IV. DISCUSSION AND CONCLUSION

### A. Discussion

Several green practices of the Sri Lankan large scale apparel industry were analyzed by this study. According to the previous literature by (Dheerasinghe, 2003) the current study selected thirty large scale apparel companies which are practicing green practices currently. The organizational performance was the dependant variable and the independent variables were the reduction in the environmental impact, reduction in the water usage, reduction in the energy usage and reduction in the carbon footprint. Through the analysis it can be stated that reduction of water usage, reduction of energy usage, reduction of carbon foot print and reduction of the environmental impact all have strong positive relationships with the organizational performance of the large scale apparel manufacturing industry. Also through the interviews conducted it was revealed that many of the large scale apparel manufacturers have already started recycling suitable products such as plastics by partnering with the relevant parties. Use of solar panels and push system taps for reduction of water wastage are some of the practices most popularly implemented.

In the modern business world, green practices have been identified as one of the most upcoming trends that have become a key concern towards sustainability. As per the core objective of this research, the impact of green practices on the performance of the apparel industry is analyzed. It has been identified that Sri Lanka has turned into a global player in the apparel production and exports becoming a major supplier for many leading fashion brands (Thilakarathna & De Silva, 2014). Therefore implementing more and more of the discussed green practices will help manufacturers to improve their reputation as environmental friendly manufacturers and at the same time improve their organizational performance. In the long run they will be able to make an impact on their customers' mind as sustainable parties in manufacturing.

### B. Conclusion

As the apparel sector is a key industry that contributes to a significant amount of negative environmental effects it has become an essential

factor for the apparel sector to practice ecofriendly activities throughout their manufacturing process in order to increase sustainability and protect the environment for the future generation. Minimizing the amount of energy used, reduction of carbon foot print, decrease of water usage and minimizing pollution and environmental impact are main practices to be adopted for the manufacturers in contributing towards sustainability. This study used a sample of thirty large scale apparel manufacturers to obtain data required to carry out the study. When conducting this research it became evident that most of the companies do believe implementation of green practices generates positive effects for the organization as a whole as it contributes towards the organization's success in numerous ways. There are many mechanisms that have been implemented in the apparel companies related to the main key variables energy, water, carbon footprint and the environment as a whole to minimize the wastage and the adverse effects generated due to the company's manufacturing process. As further research green practices in the small scale and medium scale apparel manufactures and their impact on the performance can be studied.

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*Allied Health  
Sciences*

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Allied Health in the Global Environment:  
Challenges and Opportunities

## SESSION SUMMARY

The session theme was “Allied Health in the Global Environment: Challenges and Opportunities”. This session comprised of four plenary speeches delivered by distinguished national and international scientists. Plenary session of Allied Health Sciences had four emerging scientific topics; “Genomics to Molecular Diagnostics to Personalized Medicine”, “Nursing in Global Environment: Challenges and Opportunities”, “Does dose matter?” and “Challenges and way forward of sports and exercise medicine in Sri Lanka”. The plenary session of the Faculty of Allied Health Sciences was chaired by Senior Professor Narada Warnasuriya. Professor Narada Warnasuriya is the Senior Professor of Paediatrics and Chairman of the Internal Quality Assurance Unit at the Sir John Kotelawala Defence University (KDU). He is also the Emeritus Professor of Paediatrics at the University of Sri Jayawardenepura (USJP). He was formerly the Senior Professor of Paediatrics, Dean, Faculty of Medical Sciences and Vice Chancellor at the USJP. The first speech was made by Prof. Ranil Dassanayake on “Genomics to Molecular Diagnostics to Personalized Medicine”. He is a Professor at the Department of chemistry, University of Colombo. He has obtained his bachelor’s degree in Chemistry in 1993 from the Faculty of Science, University of Peradeniya and has obtained his PhD in Biochemistry and Molecular Biology from the University of Hong-Kong in 2001. He has served as a senior lecturer in Biochemistry and Molecular Biology at the Department of Chemistry, University of Colombo and was a Research Associate at the Department of Microbiology at the University of Hong Kong. Second speech was made by Dr. Rasika Jayasekara on “Nursing in Global Environment: Challenges and Opportunities”. He is a senior lecturer in school of nursing and midwifery, university of South Australia. He has obtained his bachelor of science in nursing degree in 1999 from the Faculty of Natural Sciences, Open University of Sri Lanka. He completed his master of nursing science & master of clinical

science in evidence based healthcare from the faculty of health sciences, university of Adelaide, South Australia and has obtained his PhD from the University of Adelaide, South Australia. He has served as a nursing tutor, school of nursing, Rathnapura, Sri Lanka & clinical associate lecturer, The Joanna Briggs institute, Adelaide Medical School, University of Adelaide, South Australia. The third speech was one of the most interesting studies which took the attention from the audience and it was on “Does dose matter?” on medical imaging done by Mark McEntee. He is an Associate Professor of University of Sydney and he is an internationally recognized researcher and a teacher in diagnostic radiography. He was the President of the Irish Institute of Radiography and Radiation Therapy in 2005 & became a Senior lecturer in the University of Sydney in 2011 and an Associate Professor in 2014. He is an Honorary Professor of Radiography at the University of Salford, Manchester (UK), a fellow of the Irish Institute of Radiography, and has been appointed as an expert consultant by the governments of Singapore and Tonga. The final speaker of the plenary session was Dr. Lakshman Edirisinghe and the topic was on “Challenges and way forward of sports and exercise medicine in Sri Lanka”. Dr. Lakshman Edirisinghe is the Director General of Institute of Sports Medicine, Ministry of Sports. He has obtained his bachelor of surgery bachelor of medicine (MBBS) degree from University of Colombo in 1993 & Master of Science in community medicine from Post Graduate Institute of Medicine, University of Colombo in 2002 and Diploma in Environmental Management from Faculty of Science, University of Kelaniya. He was the Deputy Provincial Director of Health Services – Central Province and the Regional Director of Health Services Kurunegala District. He is a Council Member of College of Medical Administrators, member of National Steering Committee of Maternal and Child Health & many more respective institutes & organizations. At the end of all speeches Prof.

Narada Warnasuriya opened the session for the discussion started with the first speaker. Dr. Kottahachchi and Dr. Chandana commented and inquired about virus activity from Prof. Ranil Dassanayake and had a good discussion on the topic. As the second discussion Prof. Narada started with asking about nursing professional bodies in Australia from Dr. Rasika. Then Dr. Lakshman and Prof. Mark commented on the same topic. Mr. Rahal inquired about the safety and mutations happened due to the exposure of X-ray from Prof. Mark as the third discussion. Prof.

Narada Warnasuriya also commented on the safety of radiography and radiotherapy profession and had a fruitful discussion on the topic. Last discussion was on the situation of sports medicine in Sri Lanka. Prof. Ranil and Mr. SADCS Senevirathna asked about the facilities, services provide by the sports medicine unit of sports ministry. Dr. Lakshman Edirisinghe commented on the issues and challenges in sports medicine in Sri Lanka. At the end of the plenary session chairperson, Senior Prof. Narada Warnasuriya congratulated the speakers again and stated that the session was very interesting as well as an interactive one.

## Technical session I

Radiography & Radiotherapy The technical sessions on Radiography/Radiotherapy conducted under the theme Allied Health in the Global Environment: Challenges & Opportunities was chaired by Dr Jayantha Balawardane Senior Lecturer Grade I in Faculty of Medicine, Head of the Department of Radiography & Radiotherapy, Faculty of Allied Health Sciences and Executive Director of the University Hospital KDU. The session commenced with the presentation on Assessment of Frequency of Errors in Dental Panoramic Radiographs at Dental hospital, Peradeniya, Sri Lanka. The collaborators of the research were AJSP Nileema, L Thasanthan, DLBO Abayarathna. The objective of the research was to determine the frequency of errors that occurred during DPTs and to minimize the further occurrence. Researches were collected 250 DPTs and assessed for presence of errors in categories including patient preparation, patient positioning, patient motion, handling and processing and exposure. There were only 22 (9%) error-free DPTs. Two hundred and twenty-eight (91%) radiographs had errors. Six percent of the DPTs were unacceptable and had to be re-taken. Fifty-nine percent images had patient positioning errors being the most frequent error. Thirty one percent of errors were due to processing and handling followed by 7% of errors and 3% of errors due to patient preparation and exposure errors respectively. There was no patient motion error during exposure. The researchers concluded that the frequencies of errors in conventional DPTs were relatively high in this study with patient positioning being the most frequent error. Professor Mark McEntee, University of Sydney stated that the reviewer's sensitivity should be checked by giving them set of radiographs prior to the study. The study on knowledge on breast cancers amongst females in Katuwawela North, Boralesgamuwa, Sri Lanka was presented by AH Somathilake, CM Hettiarachchi, HS Niroshani, SH Egodage. The aim of the research was to determine the level of awareness of breast cancers among females by exploring their knowledge on risk factors, Breast Self-Exam-

ination (BSE) and screening modalities of breast cancers and to find out the correlation of selected socioeconomic characteristics with the knowledge on breast cancers. The study concluded that an increase in the education level of the participants was significantly associated with the increase in the overall awareness level on breast cancers and increase in the economic status of the participants also has a significant relationship with the increase in the level of awareness on breast cancer. Furthermore, it was found that there is a negative relationship with the increase in age and the level of awareness on breast cancer. This study has depicted that majority of respondents are aware of breast cancer as a disease entity, but their knowledge and understanding of the disease is very low. Therefore, a breast cancer awareness campaign is essential to improve the knowledge on breast cancers. Professor Mark McEntee discussed about the misunderstandings about the breast cancers amongst the women in Katuwawela area. Dr. Kottahachchi suggested to categorize the participants age in to groups and bettering to find level of awareness on breast cancer in different age groups. The study on Radiation dose received to thyroid glands of patients undergoing mammography; a comparison of Cranio Caudal (CC) and Medio Lateral Oblique (MLO) views was presented by GGC Perera, WSS Jayasinghe, WBC Nisansala, DDN Wimalarathna, GLS Galgamuwa, G Senanayake. The main objective of this study was to determine the association of Entrance Surface Dose (ESD) for thyroid between the Cranio Caudal (CC) and Medio Lateral Oblique (MLO) projections. Study has been revealed that ESD for thyroid gland from the projections of MLO is higher than CC. In addition, the compression of breast thickness is significantly associated with ESD values of the thyroid gland. Professor Mark McEntee stated the other methods available for dose reduction of the thyroid gland during mammography. The study on patients' perceptions and knowledge regarding to the nuclear imaging examinations at a selected hospital in Western Province, Sri Lanka presented by DMPR Dissanayaka, N

Jayabhaskar, P Sathyathas, JMC Udugama. The aim of this study was to find out the patient's perceptions and knowledge about nuclear imaging procedures. The researchers concluded that the median score was lower (30) for total 100 marks and majority of the patients (77%) not aware about nuclear imaging procedures by the time of prescription. Chi-square test showed that there were significant differences in the perception and knowledge with patient's type of occupation ( $P=0.000$ ), residence ( $P=0.000$ ) and educational background ( $P=0.000$ ). Mann-Whitney test

showed that health related occupied patients had higher knowledge ( $66.956 \pm 15.056$ ) compared with non-health related occupied patients ( $32.967 \pm 14.774$ ). There were differences of perception and knowledge regarding to the nuclear imaging examinations between the urban ( $38.642 \pm 18.317$ ) and rural ( $25.556 \pm 15.056$ ) patients and among different educational categories. Majority of patients had lack of perceptions and knowledge regarding to the nuclear imaging examinations and procedures.

## Technical Session II

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Medical Laboratory Sciences The session comprised of research studies conducted by undergraduates of Medical Laboratory Sciences. The session was chaired by Vidya Jothi Senior Professor Resvi Sheriff who is currently attached to the Department of Clinical Sciences, Faculty of Medicine, KDU. Dr Chandrika Nanayakkara, a Senior Lecturer attached to the Department of Plant Sciences, University of Colombo, Dr. Inoka Uluwaduge, a Senior Lecturer and the former coordinator of the Medical Laboratory Sciences Degree programme University of Sri Jayewardenepura and Dr Prasanna Galhena, Head, Department of Biochemistry and Clinical Chemistry, Faculty of Medicine, University of Colombo served as the Judges in the session. Out of five presentations amongst the six papers presented were delivered by five Medical Laboratory Sciences undergraduates of intake 30. Among them Ms. CK Nandasena presented her research titled "Association between changes in liver transaminases and full blood count among patients with RT-PCR positive Dengue and RT-PCR negative other febrile illnesses admitted to Teaching Hospital-Peradeniya, Sri Lanka. The importance of usage of liver transaminases in patients suspected for Dengue infection was highlighted in the presentation. Comments by the audience suggested to confirm the RT-PCR negative patients among the sample in order deliver a sound outcome. Ms GGPN Kulasooriya presented her

paper on prediction of the presence of microalbuminuria by analyzing total urine protein to creatinine ratio in diabetic nephropathy patients in District General Hospital, Ampara, Sri Lanka. The research on identification and prevalence of risk factors in bacteraemic patients at Apeksha Hospital-Maharagama, Sri Lanka was presented by Ms. SLA Lenaduwe. Ms JASN Jayasinghe presented her findings on association of hypertension and renal impairment with different dietary patterns of apparently healthy individuals in area of medical officer of Health, Dompe, Sri Lanka. The reasons for lack of significant elevation of triglycerides in subjects consumed fatty foods were questioned by the Chairperson. The research titled correlation between anemia and renal function among type 2 diabetes mellitus patients in General Hospital Ampara was presented by Ms EMDT Edirisinghe. The lack of investigation on other potential factors that could cause anemia in patients were highlighted by the Judges. Mr. GK Wijesinghe, MLS graduate from the University of Sri Jayewardenepura presented his paper on effect of laboratory culture media, citrate encapsulated and Curcumin encapsulated layered double hydroxides on in-vitro *Pseudomonas aeruginosa* biofilm growth. It was suggested to look for any methods to get rid of biofilm formation in future research by the judges.

## Technical Session III

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Physiotherapy & Occupational Health The session theme was Physiotherapy and Occupational Health. This session was chaired by Dr. Chandana Karunathilake. He is a senior lecturer in Pathology in Faculty of Medicine in General Sir John Kotelawala Defence University. He obtained in MBBS and Masters in Surgery in Sri Lanka and he is a member of Royal College of Surgeons. While serving as a consultant Orthopaedic surgeon over 19 years he has engaged in Research in the areas of Orthopaedics and Road Traffic Trauma. He has won the gold medal for College of Surgeon oration in 2014. The judge panel of this technical session consisted of three experts in the area of Physiotherapy. They were Dr. Lakshman Edirisinghe-Director, Institute of Sports Medicine- Sri Lanka, Dr. Nishanth Kumarasinghe- Senior Lecturer in Anatomy in Faculty of Medicine in General Sir John Kotelawala Defence University, and Mr. TDMSB Dasanayake, Senior Lecturer in Physiotherapy- Department of Allied Health Sciences, Faculty of Medicine- University of Colombo. Six speakers presented in this technical session. Firstly Mr. MHH Sandaruwan- Department of Allied Health Sciences, Faculty of Medicine, University of Colombo, Sri Lanka presented under the topic of “Determinants of Balance Confidence (BC) And Standing Balance Performance (SBP) in Stroke survivors with Hemiplegia”. He concluded by their research study that dominance of affected side influences both BC and SBP. Age and gender showed significant associations with BC and SBP respectively. BC and SBP should be included in assessment and rehabilitation of stroke survivors with residual hemiplegia due to their high correlation. During the question and answer time; judge panel questioned whether this study participants were hemiplegic (paralyzed) or hemiparetic (only weakness). Presenter answered that he took only paralyzed patients at the beginning of the study. The audience asked about the BMI of the study participants and the speaker said BMI was not excluded and that he has included all the people with various BMIs in the sample. Judge panel inquired about the reason for BC had a significant negative correlation with age that is not similar to literature. Chairperson inquired presenter whether any extreme figures of age were recorded. Yet presenter said he did not find such extreme of age. Second the presentation was on “Comparison of Balance Deficiency in Chronic Low Back Pain Patients (CLBPPS) and Healthy Persons

(HPS)” by Miss. APGA Arunodanie from Department of Allied Health Sciences, Faculty of Medicine, University of Colombo, Sri Lanka. The study concluded that CLBPPS had impairment in balance when compared with HPs. Intensity of pain was negatively correlated with balance. Inclusion of balance exercises to the treatment procedure of CLBPPS is important. During the question and answer session, the audience inquired about the association on dominant side and the gait with LBP to which the speaker answered that those factors were not analysed in her study. The judge panel said the leg length discrepancy and SI joint pathology are the main contributing factors for balance and LBP and suggested to include such factors as well. And one of the judges inquired about the exclusion criteria as she excluded a lot of medical condition like labyrinthitis by questioning by the participants. The judge said it is not possible to diagnose those conditions only by asking patients and it should be medically diagnosed or should be taken from medical records. The third oral presenter was Miss N Priyadarshani- Allied Health Sciences Degree Programme, Faculty of Medicine, University of Ruhuna, Sri Lanka. She presented on “Prevalence and related risk factors of recurrent falls among ambulatory community dwelling elderly in Galle district, Sri Lanka”. In conclusion, she said in this study, presence of diabetes mellitus and balance/gait problem or foot abnormality were identified as risk factors for recurrent falls. She said that this study emphasizes the importance of adhering to precautionary measurements in preventing recurrent falls among elderly to enhance the quality of life and facilitate healthier aging with minimal complications. During the question and answer session the judge panel said since she had done the study in 10 divisional secretarial area only, it should not mention in the topic as in Galle district and to change the topic as divisional secretarial area. Further they inquired about a result on females are more risk on falls than males. They highlighted since she has obtained more females than males for the study, the results figure too might favour in females. The other question was on environmental and behavioural factors act on risk factors for falls as results were different with literature. They discussed on environmental and behavioural factors as access to bathroom and access to washing area usually act as risk factors for falls. The panel of judges suggested it is better to



study on association of falls with hyperglycemic status and diabetes polyneuropathy rather than study on association of falls with presence of diabetes mellitus. Audience inquired the association of falls with poor vision yet the study had not analysed that aspect. The chairperson highlighted the importance of using qualitative data to increase the validity and reliability of the study. Fourthly, Mrs. WGRMS Nandakumara from Unit of Allied Health Sciences, Faculty of Medicine, University of Jaffna, Sri Lanka presented on “Factors influencing on quality of work-life of the nurses working in teaching hospital Jaffna, Sri Lanka”. She concluded that nearly more than half of the population showing their dissatisfaction on their quality of work life, even though in this study only two factors were showing the relationship with the quality of the work life. Thus, there is need of conducting a qualitative in-depth interview research approach to identify the more factors, and this may help to take necessary action to improve the quality work of life of nurses in Teaching Hospital, Jaffna. The panel of judges inquired about the questionnaire since she has used an Indian one which was not validated in Sri Lanka but she has pretested that questionnaire with 20 participants. They discussed the most significant work-related factors were not identified because of using the Indian questionnaire which was not validated. Suggestion was to include a qualitative part to the study. Fifth Speaker was Miss. RMHM Rathnayaka from Department of Nursing and Midwifery, Faculty of Allied Health Sciences, General Sir John Kotelawala Defence University, Sri Lanka. The title was on “Assessment of awareness of three-wheeler drivers on first aid when handling and transporting traumatic victims following road traffic accidents in the Colombo district, Sri Lanka”. In conclusion, this study showed they have considerable knowledge on first aid. So, proper awareness programs, including first aid in school curriculum and making people aware on first aid through media will assist the three-wheeler drivers and lay people to perform immediate lifesaving activities thoroughly and effectively. Chairperson commented on discussion of the study with

data as she used 2012 data. The panel of judges questioned on how to quantify overall knowledge and she described about the questionnaire. Audience asked about the awareness on study participants on measures to prevent bleeding and transporting the injured people. She answered that most of the three wheel drivers knew the importance of transporting injured people with cervical collar and lumbar board but they are not practicing due to practical difficulties. Then chairperson discussed on regarding the importance of correct way of transport traumatic victims following road traffic accidents to prevent further injuries. He said more than 50% of Spinal Cord injury (SCI) is secondary and also most of the traumatic victims in Sri Lanka are transferred to the hospital through three wheelers. He revealed that recently a pilot study was conducted to introduce a practical method of transport victims in three wheelers such as keep knee hip bended and back is straight on seat. The final speaker of this session was Miss. K.I.G. Hevawitharana from Institute for Combinatorial Advanced Research and Education, General Sir John Kotelawala Defence University, Ratmalana, Sri Lanka under the topic of “Risk factor distribution among people affected with the Chronic Kidney Disease (CKD) In Padaviya, Sri Lanka”. She revealed that the chronic kidney disease (CKD) remains at epidemic proportions in north central province of Sri Lanka where majority of the patients are reported to be of unknown etiology (CKDu). The results suggest that 1) the prevalence of the disease with a history of initiation risk factor could be substantial so that the risk factor distribution deserves attention, and 2) risk factor management should prove useful in improving health of the CKD/ CKDu patients. The judge panel inquired about the literature on her result as majority is CKDu as it contributed as a minor contribution in literature. Further judge panel suggested reporting is not adequate in a scientific forum and should be more scientific.

## Technical session IV - Pharmacy

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The Pharmacy session was chaired by prof. BMR Fernandopulle, a professor of clinical pharmacology and therapeutics of KDU. She is also a member of several national expert committees of the Ministry of Health, Sri Lanka including the Drug Evaluation Committee of the National Medicines Regulatory Authority, Technical Advisory Committees of Malaria, Filariasis and TB. The chair was introduced by Dr. Darshana Kottahachchi, Acting Dean of FAHS, KDU. Five research papers were presented at the session by the authors SM Abdulla, MGS Malkanthi, R Sarveswaran, Dr WASS Weerakoon and DVGC Priyadarshani respectively. Dr AK Chandana, Senior Lecturer, Department of Basic Sciences, KDU, Werahara and Dr. Gayani Abayaweera, Senior lecturer, Department of Chemistry, University of Colombo were the members of the judge panel. Each presenter was given 10 minutes to present their research findings followed by 4 minutes question/answer session. The session commenced with the presentation titled "Computational study of angiotensin converting enzyme and renin with phoenicanthusine" presented by SM Abdulla from Industrial Technology Institute, Colombo. She talked about in silico approach which allows a faster and cheaper identification of promising drug candidates by the virtual screening of compound databases. She mentioned in her study that, Sri Lankan natural product database was virtually screened against ACE and Renin. Potent hit has been put through refined docking using different algorithms and an advanced scoring function has been used to filter the best results. Her study showed that, for both ACE and renin, Phoenicanthusine exhibits favourable results. Moreover, she said that Phoenicanthusine is an endemic natural product of Sri Lanka, and is isolated from the stem bark of Phoenicanthusobliqua. Ms. MGS Malkanthi from Department of Nursing, Faculty of Health Sciences, Open University of Sri Lanka presented about the factors related to readmission of patients with schizophrenia. Objective of her study was to examine the factors related to readmission of patients with schizophrenia at National Institute of Mental Health (NIMH), Angoda, Sri Lanka. She mentioned that Demographic, socio economic, disease related and cultural factors related to readmission were collected from parents or guardians of the patients diagnosed as

schizophrenia. The results of the study highlighted that, readmission of patients with schizophrenia were mainly caused by social and economic related factors in Sri Lanka. Therefore, health education should be carried out to improve knowledge and establish positive attitudes regarding psychiatric disorders while improving the health facilities. The third presenter, Ms. R. Sarveswaran was from the Department of Allied Health Sciences, Faculty of Medical Sciences, University of Sri Jayewardenepura, Sri Lanka. Her presentation topic was "Toxicity studies on aqueous extract of flower and stalk of Aponogeton cryspus in rats". The aim of her study was to evaluate the short term and sub chronic toxicity of flower and stalk of optimum effective dose for hypoglycaemic activity of A. cryspus in Wistar rats. Rats in the test group have been orally treated with the aqueous crude extract of combination of flowers and stalk of A. cryspus and control group has been given distilled water for consecutive 14 days for evaluating the short-term toxicity and further for 28 consecutive days for sub chronic toxicity. The study showed that the aqueous extract of flowers and stalks of Aponogeton cryspus does not exert any toxic effects at a dose of 90 mg/kg. The presentation titled "Chronic anti-inflammatory effect of Sudarshana suspension on adjuvant-induced arthritis in rats" was presented by Dr. WASS Weerakoon from Department of Ayurveda Paediatrics, Institute of Indigenous Medicine, University of Colombo, Sri Lanka. She talked about Sudarshana powder (SP) which is a very effective anti-pyretic Ayurvedic preparation, extensively used in Sri Lanka as well as in India. The aim of her study was to evaluate the effect of Sudarshana suspension (SS) on the progression of adjuvant-induced arthritis in rats. Further, she mentioned that following induction of arthritis, daily oral treatment was started on day 14 and continued up to day 28. Body weights (BW), hind paw ankle joint thickness (AJT) and foot pad thickness (FPT) were measured in all animals. Treatment with SS and standard drug Celecoxib in the arthritic animals produced significant reductions ( $p < 0.001$ ) in FPT, AJT, WBC count, reduction of erythema and oedema in the ankle joints and foot pad of the AIA rats. Further, the BW was normalized. She concluded that SS possesses anti-inflammatory effects on arthritis. The final presentation of the session was "Risk of diabetes

mellitus in Ampara area using a risk prediction model: a case control study” presented by Ms. DVGC Priyadarshani from Department of Medical Laboratory Sciences, General Sir John Kotelawala Defence University. Her study focused on identification of the family history and lifestyle related risk factors with their proportionate contribution to Diabetes Mellitus (DM) by an estimated predictive risk value through a case control- study. She has collected socio demographic, anthropomorphic and lifestyle related risk factors with medical history from the DM patients and

controls at the Ampara General Hospital in Sri Lanka. She concluded that the family history of DM and non -occupation could play a main role in development of DM in relation to Ampara area. At the end of the session certificates were awarded to presenters and judges and a memento was presented to Prof. MBR Fernandopulle.

## Parallel Session Nursing & Midwifery I

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The first technical session of Nursing & Midwifery of the Faculty of Allied Health Sciences was chaired by Dr Namal Wijesinghe, Senior Lecturer in Medicine and Head of the Department of Clinical Medicine, Faculty of Medicine, General Sir John Kotelawala Defence University. The panel of judges of the session were Dr Rasika Jayasekara, Senior Lecturer in Nursing & Midwifery, School of Nursing & Midwifery, University of South Australia. Dr. SSP Warnakulasuriya and Ms SMKS Senevirathna, Senior Lecturers in Department of Allied Health Sciences, Faculty of Medical Sciences University of Sri Jayewardenepura. The session consisted of six oral presentations and the first presentation was done by Mr APGC Prasad, on 'Knowledge, attitudes and practices towards childhood immunization among mothers attending Child Welfare Clinics in Medical Officer of Health area, Ratmalana, Sri Lanka'. Chair congratulated the first speaker. A comment raised by the Chair was to do a religious comparison of the above study. The next oral presentation was done by Ms. K Abhayasinghe on Scientometric mapping of mental health research publications in India and Sri Lanka, Dr Namal Wijesinghe commented on the study and stated the importance of including the number of papers published per million of the population to enhance the validity of the findings. Dr Rasika Jayasekara appreciate her study and expressed further about the databases available for facilitate the systematic review studies. Ms KMSDK Dissanayaka, from Department of Nursing & Midwifery, Faculty of Allied Health Sciences did the presentation on her findings on "Knowledge, Attitudes and Practices (KAP) about Dengue prevention among residents in Rathmalana MOH area". Chair and the judge panel was stated it as a timely topic to be addressed. Dr SSP Warnakulasuriya commented on

her sampling method. Audience commented that the same study should be carried out among the administrative people in public & Government places. The fourth oral presentation was drawn the attention from the audience since it was done by Nigerian student Ms EO Shobowale who is attached to Department of Nursing & Midwifery, Faculty of Allied Health Sciences. It was on "A review of sickle cell disease in Nigeria and the way forward". Ms HHS Kaushalya presented on the title on "Post-Traumatic Stress symptoms among adolescents, who were exposed to Ammunition Depot Blast; Salawa, Sri Lanka". Most of the audience were interestingly gave their positive comments on the study. Dr Rasika Jayasekara commented that the importance of the continuous follow-up of the study subjects to minimize the risk of developing PTSD among them in future. The speaker of the final presentation of the second technical session on Nursing was done by Ms.BS Chathurika, title on "Knowledge and Depression literacy among G.C.E. Advanced Level students in Kalutara Educational Zone, Sri Lanka" Dr Rasika Jayasekara stated the importance of assessing the prevalence of the depression among the students. At the end of the six oral presentations the chairperson, Dr. Namal Wijesinghe commented that as necessity of including male population as he observed that the majority sample was consisted with female among many of the studies. He encouraged all the other participants to come up with more valuable findings in next International research conference of the KDU. Finally, he congratulated the speakers again and stated that the session was very interesting as well as an interactive one and he expressed his sincere thanks to the panel of judges & the all participants.

## Parallel Session Nursing & Midwifery II

The second technical session of Nursing & Midwifery of the Faculty of Allied Health Sciences was chaired by Dr GDI Rodrigo, Senior Lecturer in Paediatrics and the head of the department of Medical Education, Faculty of Medicine, General Sir John Kotelawala Defence University. The panel of judges of the session were Dr Rasika Jayasekara, Senior Lecturer in Nursing & Midwifery, School of Nursing & Midwifery, University of South Australia. Dr. AATD Amarasekara, and Dr MKDL Meegoda, Senior Lecturers in Department of Allied Health Sciences, Faculty of Medical Sciences University of Sri Jayewardenepura. The session consisted of five oral presentations and the first presentation was done by Ms RADS Udayangi, from Department of Nursing & Midwifery, Faculty of Allied Health Sciences, KDU, on “Knowledge and attitudes of antenatal mothers regarding neonatal care in a selected Medical Officer of Health area, Sri Lanka”. A comment was raised by the Chair asking the reasons for thinking that the mothers did not have knowledge regarding immunization and was answered as that these mothers didn't answer the questions regarding the age gaps of immunization, types of vaccines given to the babies and the importance of those vaccines. The Chair further stated that it must be due to the frequent changes of the EPI schedule in Sri Lanka. The next oral presentation was done by Ms. KSS Kaushalya from the Allied Health Sciences Degree Program, Faculty of Medicine, University of Ruhuna, on “Domestic Violence Exposure of Married Women in Isurumuniya PHM Area in Anuradhapura, Sri Lanka”. Chair congratulated the speaker on the study, as it is a difficult area to do a research and challenging to deal with the knowledge level of those people. Dr SSP Warnakulasuriya commented on her definitions about the criteria of violence mentioned in her study. Dr Rasika Jayasekara stated that it was a surprise to see the collusion of the knowledge level of these women and asked about any support system to help them. The Chair stated that ultimately a research should have some value and asked the speaker to try and put the findings of her study in to action to help those poor women through police and empower them to have good knowledge regarding domestic violence. The third presenter was Ms RDUP Sugathapala from Department of Nursing & Midwifery, Faculty of Allied Health Sciences, KDU. She did the presentation on her findings on “Patterns of healthcare seeking behaviour

during bouts of Upper Respiratory Tract Illnesses among preschool children in Kurunegala Municipal Council Area, Sri Lanka”. Dr Rasika Jayasekara commented on her data collecting method and the chair wanted to know how she differentiate Lower respiratory tract infections (LRTI) and Upper respiratory tract infections (URTI) and the usage of antibiotics. The fourth oral presentation was done by Ms N Rathnayake from Allied Health Sciences Degree Programme, Department of Physiology, Faculty of Medicine, University of Ruhuna. Her topic was “Impact of socio-demographic status on quality of life of pre-and postmenopausal women in Galle, Sri Lanka”. The chair stated that when interpreting the findings regarding the quality of life of postmenopausal women, we need to be very careful since there are many confounding variables. For an example, she raised a question as being in which basis that we can say people with high income have more quality of life rather than people with low income. Ms JAD Iroshika Kumari from Teaching Hospital, Kandy was the final presenter of the session and she presented on the title on “Depressive symptoms among Cancer Patients Undergoing Chemotherapy at Teaching Hospital, Kandy, Sri Lanka”. At the end of the presentation, Dr Rasika Jayasekara asked whether she could find any relationship between duration of cancer and depressive symptoms. Ms Iroshika stated that statistically there was none. The judge panel commented about the importance of having counselling programmes and the continuous follow-up to help these patients in the hospital and Ms Iroshika stated that she had already emphasized this to the ward masters there and in some wards they have already started to use music therapy and religious activities in order to aid the psychological and spiritual needs of those cancer patients. At the end of the five oral presentations the chairperson, Dr GDI Rodrigo highly appreciated the talent and the enthusiasm showing by the nursing students to conduct researches which is even more than medical students' capacity. She finally congratulated the speakers once again, stating that the session was very interesting and expressed her sincere thanks to the panel of judges and all the participants. The session was concluded after distributing the certificates to the presenters and tokens of appreciation for the Chair and the judges.

*Plenary  
Speeches*

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# ALLIED HEALTH IN GLOBAL ENVIRONMENT: CHALLENGES AND OPPORTUNITIES

**Dr R Jayasekara**

School of Nursing and Midwifery,

University of South Australia

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Healthcare is changing dramatically due to the advancement of medical sciences and technology, the abundance of clinical research and the higher demands of consumers. These changes represent a significant challenge to the healthcare professions and education in terms of maintaining the quality of services and preparing healthcare professionals for the future. Effective systems for regulation, education, research and management are key to strengthening the contribution of healthcare professions in order to achieve the required improvement in health outcomes (ICN 2017; WHO 2017; World Bank 2017). In response, healthcare professionals' education and services are increasingly being restructured in many countries to prepare them for contemporary and future demands of healthcare. It is estimated that there are 43 million global health workers in 2015, including 9.8 million physicians and 20.7 million nurses/midwives (WHO

2017). To maintain this enormous workforce requires approximately 3,000 educational institutions, which produce approximately 1 million new healthcare graduates each year (WHO 2016). It is essential to ensure that new healthcare graduates achieved the required standards and competencies to practise in order to provide safe and effective healthcare. However, many healthcare professionals in particular allied healthcare professionals face poor working environments, lower-level wages, unsupportive management and a lack of social recognition and career development (WHO 2016). It is therefore essential that governments and other institutions involved in human resources for health should establish effective strategies designed to ensure adequate policies in order to create safe and effective healthcare system that are able to deal with challenges presented today and the future.

# GENOMICS TO MOLECULAR DIAGNOSTICS TO PERSONALIZED MEDICINE

**Prof R Dassanayake**

Department of Chemistry, University of Colombo,

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Genomics is the study of genomes, the blue print of life, within the field of molecular biology, and this includes genes, regulatory sequences, and other information contained within the noncoding regions of an organism's DNA. The genomics is one of the fastest growing areas of Molecular Biology with constant introduction of new-advanced robust technical platforms for genome sequencing that facilitates generation of the alphabet of life, in a rapid and economical manner to assist investigation of the formula of the life forms. Given the importance of genomics in molecular biology and its central role in determining the fundamental operation of cellular processes, expansion of knowledge in this area undoubtedly facilitates medical advances in different areas of clinical interest that may not have been possible otherwise. Molecular diagnostics, essentially the analysis of DNA and RNA at the molecular level, is a fast-growing business, made possible by the growing understanding of the human genome, which has driven growth in the diagnostics industry. Molecular biology has held out the promise of transforming medicine from a matter of serendipity to a rational pursuit grounded in a fundamental understanding of the human genome and the mechanisms of life. Molecular biology has begun to infiltrate the practice of medicine and genomics is hastening these advances. Within next few decades, comprehensive genomics-based health care should be the norm.

Scientists will understand the molecular foundation of diseases, be able to prevent them in many cases and design accurate, individualized therapies for illnesses. Molecular diagnostics involves multiple technologies to identify genetic variations in individual patients. These technologies include PCR, FISH, hybrid capture, sequencing, microarrays etc., and has applications in testing for infectious diseases and genetic disorders, early diagnosis of leukaemia and cancers, screening of blood and for blood disorders, DNA fingerprinting (e.g., paternity testing, forensic testing), and also in microbiology, tissue typing, and food pathogen detection testing. Further, it has applications in prognostic marker detections related to diseases and personalized therapy identification that leads to the selection of the most appropriate and effective drugs according to the individuals' genetic makeup. Finally, Genomics, Molecular Diagnostics and Personalized Medicine can be considered as one of the greatest intellectual enterprises of humankind that provides the impetus to fulfil the potential of understanding life processes and utilizing them to the advantage of humanity. Although, these are the fastest growing knowledge-based sectors even amongst our neighbouring countries such as China, Japan, India, Korea, Singapore, Malaysia, Taiwan, Thailand etc., Sri Lanka has yet to harness the full potential of these areas of Molecular life science.



# DOES DOSE MATTER?

**Associate Prof Mark F McEntee**

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On the discovery of x-rays their use in medical imaging was immediately obvious. After the initial excitement about the wondrous “invisible light”, came a period of realisation where many martyrs to radiation fell. Technology for x-ray imaging developed rapidly and quickly became safer. Then there was a new expansion into new imaging technologies fluoroscopy, CT, and more advanced imaging techniques like angiography, and CT fluoroscopy. Although radiation increased with each of these examinations that was not considered to be significant as imaging examinations were few and far between. In the 1980s-computed tomography became increasingly more common, and patients were more likely to be exposed to a higher dose of radiation on a more frequent basis. The fear of radiation from x-ray examinations began to creep into the public concern. Articles began to appear in were leading newspapers such as the New York Times hand-wringing about the dangers of high-dose radiation, particularly to children. Now we have the combinations of these powerful x-ray examinations of CT with positron emis-

sion tomography (PET). The patient has an injection of a radioisotope at the same time as being exposed to ionising electromagnetic radiation. One theory, that of hormesis, would indicate that the body is well-prepared for these low doses of radiation than the normal repair pathways will be successful in repairing radiation damage at this level. In fact, hormesis might indicate that an initial low dose of radiation, could signal cells to prepare for upcoming higher dose of radiation. Alternatively, and perhaps more worryingly, the linear no threshold model indicates that no dose, is a safe dose. Proponents of this model indicate that modern radiation exposure to young children is leading to significant increases in cancer development and mortality. As we move forward with the use of PET/ CT, how worried should we be about the use of radiation particularly in young children?

# CHALLENGES AND WAY FORWARD OF SPORTS AND EXERCISE MEDICINE IN SRI LANKA

**Dr L Edirisinghe**

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In the background of a dramatic demographic transition in Sri Lanka, with the increase in life expectancy and the steady decline in fertility (2.13 in 2014), Sri Lanka is aging rapidly. It is projected that by 2020, 20% of Sri Lanka's population will have reached age 60 or over. Mortality rate, currently at 6.2 per 1,000 population (CDR in 2016), has been declining since independence according to published statistics. Sri Lanka is also in an epidemiological transition. Malaria, tuberculosis, Japanese encephalitis, diarrhoea, vaccine preventable diseases in childhood and acute respiratory infections are eradicated or controlled effectively except for dengue, but cardiovascular and cerebrovascular diseases, diabetes, and cancer are increasing in an alarming trend. Tobacco, substance and alcohol abuse have also increased in magnitude over the past two decades. Childhood obesity is becoming a huge concern while under nutrition is still a problem in certain sectors of the society. Under these circumstances chronic diseases and diseases related to mobility leading to poor quality of life is becoming a public health problem in Sri Lanka. Although there is a countrywide comprehensive network of health care centres, hospitals and other medical

institutions, with about 57,000 hospital beds and a large workforce engaged in curative and public health activities, whether our health system is oriented enough to address the emerging epidemiological pattern should be revisited by the all relevant stakeholders at this important juncture. In this backdrop there is a strong argument that Sport and Exercise Medicine will have to adapt quickly to take advantage of the broader application of Exercise Medicine in our system without delay. We will need to demonstrate our effectiveness in this area and usher a solution to one of the largest problems facing our health service today: developing sustainable prevention, treatment and rehabilitation models for chronic disease and conditions related to physical inactivity. This has enormous potential for expansion of SEM services, but not without its challenges as you will see once it is going to be implemented. We should be ambitious in our thinking when engaging with public health, primary and secondary care and other organisations which may offer opportunities for the specialism to be developed in Sri Lanka. Let's join hands to develop a stronger and a healthier nation.

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*Technical  
Session*

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(ORAL & POSTER PRESENTATIONS)

# KNOWLEDGE, ATTITUDES AND PRACTICES (KAP) ABOUT DENGUE PREVENTION AMONG RESIDENTS IN RATMALANA MEDICAL OFFICER OF HEALTH AREA

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**Abstract** – Dengue is contributing to considerable morbidity and mortality rates in Sri Lanka and that is one of the leading causes of illness in Western Province, where Colombo district has the highest number. This study was planned to assess KAP about dengue prevention among residents in Ratmalana Medical Officer of Health (MOH) area.

A descriptive cross sectional study was carried out during April to June 2016 among residents in Attidiya North in Ratmalana MOH area. An adult householder from every third house of the area was selected for the study. A pre-tested, structured, interviewer-administered questionnaire was used as the data collection tool which included four sections for socio demographic data, knowledge, attitudes and practices regarding dengue prevention. Data was analysed using descriptive statistics and SPSS 23 was used as the statistical software.

There were 312 participants for the study and 104 (33.3%) were males. Almost all the participants, (306, 98.1%) identified dengue fever as a mosquito borne disease while only 86 (27.6%) participants had correctly stated the features of the mosquito. Nearly 95% of participants stated that clear

stagnant water is the breeding place of dengue mosquitoes. Further, 304 (97.4%) respondents had a positive attitude that dengue patients have a chance for a full recovery by immediate treatment.

There were 188 (65%) subjects who had participated in cleaning activities within 3 months before data collection. Further nearly three-fourth of them had cleaned inside the house as a mosquito control activity but only 19.1% were interested in cleaning outside the house and road to control mosquitoes.

The study concluded that the study subjects had satisfactory knowledge and favourable attitudes regarding dengue prevention, but their practices and participation in efforts at combating dengue outside their own premises was poor.

**Keywords** - KAP, dengue prevention, residents, Ratmalana MOH area

## I. INTRODUCTION

Dengue fever (DF) is a flu-like illness, if persists can lead to the development of potentially fatal complication known as dengue Haemorrhagic Fever (DHF) that affects infants, young children and adults, but occasionally causes death (Zameer et al, 2013). There are four types of viruses (DENV-1, DENV-2, DENV-3, DENV-4) belonging to the Flaviviridae family. Infected *Aedes aegypti* and *Aedes albopictus* female mosquitoes that transmit the virus feed both indoors and outdoors during the day time. These mosquitoes grow well in areas with standing water, including puddles, water tanks, containers and old tires. Lack of reliable sanitation and regular garbage collection also contribute to the spread of the mosquitoes (WHO, 2016). It causes life threatening dengue haemorrhagic fever whose symptoms include headache, bleeding, low levels of blood platelets, and metallic taste in the mouth, low blood pressure, muscle joint pain and rashes (Shakil et al, 2015).

Today, severe dengue has become a leading cause of hospitalization and death among children in most Asian and Latin American countries (WHO, 2012). Preventable diseases such as dengue have the potential to cause the greatest mortality in a developing country like Pakistan (Itrat et al, 2008). Sri Lanka is at high risk of dengue fever. Conditions are suitable for the infection spreading and also arrive at epidemic proportion in different parts of the country which is associated with increased morbidity and mortality each year. There are two peak seasons for the spreading of dengue epidemic in Sri Lanka each year: one is from May to July; another is from October to December. Sri Lanka has confirmed dengue cases nationally. Most affected cities include: Colombo, Gampaha, Kandy and Kalutara (Epidemiological News Bulletin, 2016).

During the 1st quarter 2015, 12,035 cases of DF/ DHF and 27 deaths were reported when compared to 15,140 cases of DF/DHF and 19 deaths reported during the 4th quarter 2014. The proportion of cases notified in January, February and March were 52.7%, 31.0% and 16.29% respectively (Quarterly Epidemiological Bulletin, 2015). The highest numbers of dengue cases were reported during the last week of January, 2015. During the last 9 months of the year 2016, 41,923 suspected dengue cases have been reported to the Epidemiology Unit from all over the island. Approximately 51.29% of dengue cases were reported from the Western Province. The highest numbers of dengue cases were reported during the third week of June, 2016 (Epidemiological Bulletin, 2016).

Dengue is contributing to considerable morbidity and mortality in Sri Lanka and is one of the leading causes of illness in the Western province, where Colombo district has the highest number. The Ministry of Health Sri Lanka regards vector control as a gold standard for the prevention of dengue outbreaks, although this effort is often constrained due to operational blockages with the lack of community support and involvement in vector control programmes. Therefore, it is essential to enhance knowledge about the community's perception about dengue as well as their vector control practices before and after the initiation of any community-based vector control programmes. This study aimed to assess knowledge, attitudes, and practices regarding dengue fever among a selected population in Ratmalana Medical Officer of Health (MOH) area, Sri Lanka.

The main objective of the study was to assess knowledge, attitudes and practices about dengue prevention among residents in a selected community of Ratmalana MOH area. Specific objectives were to assess the knowledge regarding dengue fever, vector, breeding places, clinical features and prevention, to determine the attitudes towards dengue prevention and to evaluate practices regarding dengue prevention among community setting.

## II. METHODOLOGY

This study was a cross sectional descriptive study carried out among residents of Attidiya North area of Ratmalana MOH area. Participants were selected for the study by using systemic sampling method. One householder was selected from one house. List of houses was taken from Divisional Secretariat and every 3rd house was selected randomly out of the list. A pre-tested, structured, interviewer-administered questionnaire was used as the data collection tool which included four sections for socio demographic data, knowledge, attitudes and practices regarding dengue prevention. Data was analyzed using descriptive statistics and SPSS 23 was used as the statistical software.

According to the sample size calculation the sample size was 323. But only 312 participated for the study due to 11 householders rejecting to participate. All residents in the selected area were included to the study and children less than 18 years and residents who were not willing to participate for the study were excluded from the study.

### III. RESULTS AND DISCUSSION

There were 312 participants in this study. The male (33.3%) to female (66.7%) ratio was 1:2 and total population was extended over suburban areas with different educational, economical and socio-cultural backgrounds. When considering the education level, out of 312 respondents, there were 143 (53.2%) who had education up to G.C.E. Ordinary Level (O/L) and 98 (31.4%) had educated up to Advanced Level and 0.6% were without any formal education. Most of the respondents (56.7%) belonged to middle class who earned 10,000-30,000 LKR monthly. A lesser number of respondents (2.6%) had less than 10,000 LKR monthly income. Generally, all these respondents had a satisfactory educational level and monthly income.

According to the findings of this study, most of the respondents had satisfactory knowledge about dengue fever. Nearly 98% subjects knew the exact reason for spreading dengue, as mosquito bite. There was no significant association between the level of education and knowledge about DF transmission (p value, 0.21) as shown in Table 1. A research carried out in suburban area of Sri Lanka has reported that 76% respondents (Gunasekara et al, 2012), 88.5% in Malaysia (Hairi et al, 2003) and 93.5% respondents in Laos (Nalongsack et al, 2009) were aware that DF is transmitted by a mosquito vector.

**Table 1; Knowledge on dengue transmission vs. level of education**

Level of Education	Knowledge on DF transmission		
	High	Average	Low
Primary	15 (65.2%)	6 (26.1%)	2 (8.7%)
Up to GCE O/L	108 (75.5%)	29 (20.3%)	6 (4.2%)
Above	122 (83.6%)	20 (13.7%)	4 (2.7%)

Majority (95.2%) stated that clear stagnant water is the breeding place of dengue mosquitoes whereas 58 (18.6%) and 55 (17.6%) stated dirty stagnant water and both clear and dirty stagnant water as the breeding place respectively. The score distribution of knowledge on breeding places is shown in Table 2. The knowledge score of breeding places was significantly associated with the level of education (p value, 0.032).

**Table 2; Knowledge about dengue mosquito breeding places vs. level of education**

Level of education	Knowledge on dengue mosquito breeding places		
	High	Average	Low
Primary	1 (4.3%)	16 (69.6%)	6 (26.1%)
Ordinary	17 (11.5%)	101 (70.6%)	25 (17.5%)
Above	21 (14.4%)	114 (78.1%)	11 (7.5%)

Nearly a third (32.3%) gave all the correct answers on early symptoms of dengue fever and 26 (8%) participants gave all the correct answer on DHF. In another study carried out in Sri Lanka, participants had answered as high fever (94%), vomiting (69%), muscle pain (85%), headache (72%) and 25% participant had answered as rashes as symptoms (Gunasekara et al, 2012). Another research conducted in Laos found that fever was the mostly given answer as the commonest symptom (75.2%), 3% bleeding from the nose and 18.7% skin rashes (Nalongsack et al, 2009). One study revealed that most common signs and symptoms were fever and skin rashes (86.0%) as given by the participants (Hairi et al, 2003). When considering about dengue hemorrhagic fever (DHF), most of the respondents had heard about the DHF and 78% respondents had known that vomit with blood as a symptom of DHF.

Majority (85.2%) of participants agreed that DF can infect a person more than once and almost all the subjects (305, 97.8%) had attitude that anybody can get infected irrespective of the age. Only 49 (15.7%) participants agreed that the rainy season is the only season for outbreak of dengue infection and a considerable amount (255, 81.7%) had disagreed to that. Nearly one-fourth of the sample (73, 23.4%) had negative attitude on controlling dengue virus infection.

According to the results, 308 (98%) had positive attitude regarding source reduction. Most (290, 90%) of the subjects have positive attitudes towards seeking early medical treatments when a family member fall sick and the importance of having adequate bed rest and liquid intake. Majority of respondents had obtained messages about dengue from multiple sources like television (98.4%), family members (95%), health centres (MOH

office) (93.6%) and radio (90%). Other sources like newspapers, friends, leaflets, schools and internet also had provided information at a satisfactory level. Television was the most cited source of information about dengue fever in Pakistan, Malaysia and Sri Lanka (Itrat et al, 2008, Hairi et al, 2003, Gunasekara et al, 2012).

In the present study, results revealed that most of the respondents use measures to prevent mosquito bites. There were only two people who did not use any measures from the whole sample. Mosquito nets and fans were measures which were used by most of the respondents. Fan usage was highly increased in suburban areas of Sri Lanka. It can be understood by comparing with Gunasekara and others (2012).

When considering their participation in disease prevention activities like cleaning, within three months before data collection, it was 60% and it should be increase. Most of respondents (140, 74%) had enthusiasm to clean inside their home and 168 (89%) respondents have cleaned their own garden. But, dengue mosquito breeding places can occur in public places like roads, draining systems, public buildings, schools and temples. Attention to the public places was at a very low level according to the responses (36, 19%). According to the answers of respondents, they were seeking government mediation (11, 6%) and some had taken legal action to clean public drainage systems and illegal garbage discarded places.

#### IV. CONCLUSION

This study was conducted at a suburban area in the Western Province and found out the knowledge, attitudes and practices regarding dengue prevention. According to the study, most of the participants were educated and had satisfactory level of knowledge regarding dengue prevention. They had considerable level of attitudes regarding the prevention of dengue. Based on this study, it is recommended that health education programmes should be continued and intensified with emphasis on improving the practices of the urban community and educating the community on the Aedes mosquito especially its role in the spread of the disease as well as the biting times and breeding habits.

A change in the approach of health education programmes is called for based on the findings that good knowledge has not led to a good practice of control measures. Therefore, health personnel should be trained to give appropriate

counselling in an effort to change certain deeply ingrained traditional habits like domestic water storage without proper cover. Through the study, it has been observed that some facts should be modified within this area such as infrastructure facilities (proper drainage system) and waste disposal methods. The interaction between the community and the health sector should be increased for dengue prevention. The coverage of house-to-house inspections should be improved by increasing manpower and enhancing public participation.

The study concludes that the community was familiar with dengue prevention, but their participation in efforts combating dengue outside their own premises was poor. Media plays an important role in conveying increased awareness of effective control measures among the people. According to the results, regular visits of health personnel to the villages should be ensured and government mediation is a major necessity which was found through this study to get rid of dengue.

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# KNOWLEDGE AND ATTITUDES REGARDING THE EMERGENCY CONTRACEPTIVE PILLS AMONG THE DEFENCE UNIVERSITY STUDENTS IN SRI LANKA

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**Abstract** - The emergency contraceptive pill (ECP) is a method of hormonal contraception, which is indicated after unprotected sexual intercourse when regular contraceptive methods are not used. There is very scanty amount of information available in Sri Lanka regarding knowledge on the ECP. Hence, it is an important area to study as there are higher rates of maternal deaths due to unsafe abortions in Sri Lanka. ECP can be a strategy to reduce them. The objective of this study is to investigate the knowledge and attitudes regarding Emergency Contraceptive Pills among Defence University students.

This is a descriptive cross sectional study conducted among 395 undergraduates of Kotelawala Defence University (KDU) using self-administered questionnaires during the period of July to October, 2016. Study participants were selected by stratified random sampling. Data was entered and analyzed using Minitab version 14.

Among the total participants (n = 395), only 69.1% had heard of ECP. The main source of information was reported as formal education 47.1%. From the total participants, less than half, 45.5% students knew that ECP was important in post rape and 20.2% knew that it was important as a preferred contraceptive method. Among the study participants, 42.8% agreed to the idea that if ECP was readily available it might promote promiscuity among student.

Most of the students, 42.5% thought that it was more effective to take ECP soon after unprotected sexual intercourse. Only 13.7% students knew the correct time gap between the doses which was 12 hours. Higher number of students, 57.5% has not received information regarding side effects or problems that might get from ECP. Meanwhile, 13.4% stated that ECP might prevent

STI's and HIV. Among the total participants, only 25 (6.5%) had used ECP. From the participants who had used ECP, 52% of them had experienced side effects. Only 23% knew about side effects of ECP.

The current study results on influencing factors for knowledge indicated gender had a significant effect on every aspect of knowledge and attitudes on ECP while, religion did not have a significant effect on any aspect. Age, gender and year of study have a significant effect on knowledge on ECP while gender, year of study, and department has a significant effect on attitudes.

Although the general awareness on ECP was reasonably good, majority did not have a sufficient knowledge on ECP for an effective usage. Most of the attitudes on ECP were towards positive.

**Keywords** - Emergency contraceptive pills, Knowledge, Attitude, Defence University, Sri Lanka

## I. INTRODUCTION

Emergency Contraception (EC) is a method of preventing pregnancy soon after an unprotected sexual intercourse, after a sexual assault or rape, if a condom breaks or a diaphragm slips out of place, a woman forgets to take birth control pills. EC has been available for more than 30 years, (ICEC, 2012) worldwide and for about 10 years in Sri Lanka.

ECP is not a family planning method (UMM, 2012). It can be taken to prevent pregnancy within 72 hours of unprotected sexual intercourse (Byamugisha et al, 2006). It was found that the sooner the first dose was taken, the greater the effectiveness (Puri et al, 2007). The ECP, available in Sri Lanka is a single pill containing 1.5mg of levonorgestrel (progestogen-only contraceptives). These pills are also known as Postino 1 and 2.

Many pregnancies are mistimed or unwanted. These pregnancies may carry a high risk of morbidity and mortality, particularly in settings where safe abortion is not accessible or where quality obstetric services are not available for those women continuing a pregnancy to term.

According to some unrecorded data, ECP known to be a popular and common contraceptive method in Sri Lanka. Even though, ECP is very popular in the community setting, malpractice and misconceptions are the main

reasons for the poor usage of ECP (Parey, 2010). If the community is aware regarding proper usage of ECP, then it can further reduce the maternal mortality that is associated with unsafe abortions.

Premarital sexual relationships have increased globally. According to a recent research the global premarital birth percentage was 40.7% in 2012-2014. According to the above study, Asian unmarried mother rate is less when compared to the other ethnic groups in the world and it is 17% (Thalagala, 2012). A previous study conducted among advanced level students in selected districts in Sri Lanka had pointed out that 42.9% of students had engaged in premarital sex and among them only 12.2% of students had used contraceptives (Perera et al, 1999). Another study conducted in Sri Lanka, pointed out that 22% of out of school adolescents had engaged in heterosexual relationships (Thalagala, 2004).

The consequences of premarital sexual relationships are as follows; increased rate of premarital unwanted and unexpected pregnancies, increased criminal abortion rates (Puri et al, 2007), interruption of educational process, socio-economic burden, as well as health issues such as increased mortality and morbidity ratios mainly due to criminal abortions (Thalagala, 2012).

**A. Abortions in Sri Lanka and Contraceptive Knowledge**  
In the recent decades the number of induced abortion rate has been increased in Sri Lanka (Abeykoon, 2009). Hence, around 1 in 10 pregnancies end up as an unsafe abortion in Sri Lanka (Thalagala, 2012). Unsafe abortion has become the 2nd commonest cause of maternal mortality in 2010 (Atapattu, 2012). As abortions are illegal in Sri Lanka there are no reliable statistical data to be found. Nevertheless, attempts have been made to estimate the incidence of induced abortions in Sri Lanka.

In a study conducted by UNFPA and Ministry of Health in 2009, emphasized the necessity of educational programs regarding the effective use of contraceptive methods and side effects of abortions in order to reduce abortion related maternal mortality in Sri Lanka (Abeykoon, 2009). The government has recommended contraceptive methods to lower the abortion rates. A study conducted by Dr. N. Thalagala revealed the low levels of reproductive health and contraceptive knowledge among adolescents even though they are sexually active (Thalagala, 2004).

The inadequate formal health education regarding contraception, given by schools, universities and community health institutions results in the high rate of unintended pregnancies in Sri Lanka (Kumar, 2013). Furthermore, overall knowledge of contraceptive among out of school adolescents is not up to satisfactory level in Sri Lanka (Kumar, 2013).

Even though community health services target on married couples on family planning, very less facilities and information are provided to the youth who are at the verge of risky sexual behaviours (Perera et al, 1999).

The aim of this study is to determine the knowledge and attitudes of undergraduates; cadets and day scholars in the Defence University regarding Emergency Contraceptive Pills.

## II. METHODOLOGY

Study design is descriptive cross sectional study. It was carried out on both male and female local undergraduate officer cadets and day scholars of Kotelawala Defence University.

To obtain a representative sample, stratified random sampling was applied and students were divided into two stratum as health science and non health science students. Sample size was 480 undergraduates (including 25% non-response rate). Data was collected using a self-administered Questionnaire. The pilot study was carried out on randomly selected 48 students (10% of the sample size) in the Faculty of Allied Health Sciences.

Ethical clearance was obtained from the Ethical Review Committee, Faculty of Medicine, General Sir John Kotelawala Defence University. Data was entered and analysed using Minitab version 14.

## III. RESULTS

Total of 395 students answered the questionnaire (82% response rate). Majority (89.1%) was between the age group 18 to 24 years. Most of the students (97.2%) were unmarried. Majority of the respondents (66.6%) were non-medical students while the others (33.4%) medical. Most of the students (38.2%) were second years. Maximum number of the respondents 345 (87.3%) were Buddhist by religion.

### A. Distribution of Knowledge on Emergency Contraceptive Pills

Majority of respondents (69.1%) had ever heard of ECP. Regarding their source of information about ECP from the total population, 186 (47.1%) reported that they got information through formal education; 177 (44.8%) got information through friends and neighbours; 170 (43%) got information from printed materials, media and internet. Only 97 (24.6%) of participants got information through health professionals.

Higher number of students, 286 (72.4%) knew that they can obtain ECP from pharmacy. Most of the students, 172 (43.7%) said that there was no need of a prescription to obtain ECP while 49(12.4%) said that they need a prescription to obtain ECP.

Out of 395 students, 95 (24.6%) agreed with the idea that ECP was effective when taken before sexual intercourse, while majority 200 (51.7%) did not have any idea regarding the effectiveness of ECP before taken sexual intercourse. Most of the students, 167 (42.5%) thought that it was more effective to take ECP soon after unprotected sexual intercourse. However, 159(40.5%) stated that they did not know whether it was more effective to take ECP soon after unprotected sexual intercourse. Meanwhile, 122 (31.2%) students were disagreed to the idea of ECP was effective when taken 72 hours after unprotected sex; 52 (13.4%) students agreed and 212 (54.6%) stated that they did not know.

Only 54 (13.7%) students knew the correct time gap between the doses which was 12 hours. Higher number of students, 284 (71.9%) stated that ECP prevents a pregnancy while 80 (20.2%) thought that ECP terminates a pregnancy. Only, 123 (31.4%) students agreed with the idea that ECP was effective more than natural methods of contraception.

Majority of the students, 341 (88.3%) answered that they had never used ECP while 25 (6.5%) students stated that they had used. Majority of the students, 156 (39.5%) stated that ECP should be taken soon after an unprotected sex while 127 (32.1%) students answered that it was within 24 hrs. Meanwhile, 113 (28.6%) answered that ECP should be taken within 72 hrs. 17 (4.3%) stated that it was after 72 hrs. and 12 (3%) stated that it was within 5 days. Majority of the participants, 268 (67.8%) did not know that how often that they can use ECP. Only 43 (10.9%) knew that there should be at least 3 months gap while, 21 (5.3%)

answered that they can use ECP weekly or monthly and 17 (4.3%) answered that they can use it frequently. From those who had used ECP, only 13 (52%) students had experienced side effects. Higher number of students, 227 (57.5%) have not received information regarding side effects or problems that might get from ECP. Only 31 (7.9%) students received information about precautions regarding side effects or problems of ECP. Many students 188 (47.6%) had mentioned that ECP might prevent future pregnancy, 64 (16.2%) thought that ECP was illegal and 53 (13.4%) stated that ECP might prevent STI's and HIV.

**B. Distribution of Attitudes on Emergency Contraceptive Pills**

Less than half, 180 (45.5%) students mentioned that ECP was important in a situation like post rape, 177 (44.8%) answered that it was important as back up when condom breaks, 121 (30.6%) stated that it was important if oral pills were forgotten and 80 (20.2%) stated that it was important as a preferred contraceptive method. Majority of the students, 142 (35.9%) was uncertain that whether availability of ECP might promote promiscuity among students. While, 169 (42.8%) agreed to the idea that if ECP was readily available it might promote promiscuity among student.

Most of the students, 178 (45%) agreed to the idea that ECP should be easily accessible. Majority of students from those who had an opinion that ECP should be low cost, 162 (40.9%) agreed to the idea. Minority of 75 (18.9%) students answered that ECP should only be available for victims of rape while majority of the students, 179 (44.3%) answered that it should not. Majority of the respondents, 142 (38.4%) mentioned that ECP should be available without prescription while 89 (22.5%) mentioned that it should not. To the idea of that ECP should be available only for women over 18 years, majority of 145 (36.7%) agreed while others, 107 (27.1%) disagreed.

Majority of the respondents, 228 (57.7%) had answered that they might not use ECP in the future while 120 (30.4%) had answered that they might. Higher number of students, 170 (43%) had mentioned that they would recommend ECP to a friend or a relative if needed while 114 (28.8%) had mentioned that they would not recommend.

**C. Investigating of Influencing Factors to Knowledge and Attitudes on ECP**

**Table 1: Association between the knowledge with selected socio-demographic variables.**

Socio-demographic variable	P- Value	Significant Association
Age with ECP awareness	0.001	√
Gender with ECP awareness	0.006	√
Department of study with ECP awareness	0.384	x
Year of study with ECP awareness	0.003	√
Religion with ECP awareness	0.477	x

√	<b>There is a significant association</b>
x	<b>There is no significant association</b>

It was revealed that there was an association between age and attitudes on promiscuity (P-value: 0.006). But there was no association between the attitudes on promiscuity and gender (P-value: 0.983), department of study (P-value: 0.569), year of study (P-value: 0.547) and religion (P-value: 0.486).

**Table 2: Association between attitudes on future usage of ECP with selected socio-demographic variables.**

Socio-demographic variable	P- Value	Significant Association
Age	0.220	x
Gender	0.013	√
Department of Study	0.002	√
Year of Study	0.045	√
Religion	0.178	x

**Table 2: Association between attitudes on future recommendation of ECP to a friend or relative with selected socio-demographic variables.**

Socio-demographic variable	P- Value	Significant Association
Age	0.119	x
Gender	0.007	√
Department of Study	0.001	√
Year of Study	0.006	√
Religion	0.432	x

## IV. DISCUSSION

Young adults from various areas in Sri Lanka enter the University for their Tertiary Education. They are from different socio - economic backgrounds and as Sri Lanka is a multi-cultural society, they are from different religious backgrounds as well. After entering for tertiary education they experience enormous freedom therefore, it instigates them to establish new relationships. Considerable proportion of male and female school age adolescents in Sri Lanka has exposed to risky sexual activities within their secondary education (Perera et al, 1999)(Thalagala, 2004). Those adolescents enters the University for their Tertiary Education therefore, university students have a relatively higher chance of unprotected sexual intercourse. Usually, relationships compel the couple to engage in various sexual activities.

In Sri Lanka abortions are not legalized. Therefore, very less number of surveys has been conducted on unsafe abortions. From those limited surveys, it has been proved that the rate of unsafe abortions have been gradually increased from 2001 to 2008 from 8% to 13%. Unsafe abortion has been a leading cause for the maternal mortality during recent 8 years period (Kumar, 2013). Maternal mortality is an important health indicator which has a huge impact on measuring a country's development. In order to address this health burden, the Ministry of Health has suggested introducing contraceptive methods to the people and those contraceptive services at the grass root level targets married women. Even though it has implemented likewise, previous researches has highlighted the low levels of awareness in contraceptive methods (Kumar, 2013).

Furthermore, youths as a group who are at the reproductive age, they also have a risk for unintended pregnancies. Even though youth is sexually active, they are not targeted for providing adequate information regarding contraceptives. Among those who engaged in premarital sexually activities, very few has used contraceptives (Ratnayake, 2000). Due to the fact that young women engaged in premarital sexual intercourse, it is better for them to have adequate knowledge to prevent unintended pregnancies. Therefore, recommended contraceptive methods should be introduced to them. Emergency contraceptive is one method that can be introduced to them.

According to present study, considerable number of defence university students had heard about ECP, 69.1% of the respondents. Studies done in Trinidad and Iran respectively had reported 63.1% and 95.4% awareness (Parey et al, 2010)(Delaram & Rafie, 2012). Similar studies had done in Uganda and Ethiopia, the awareness on EC was respectively, 45.1% and 84.2% (Byamugisha et al, 2006)(Ahamed et al, 2012).

Main source of information was reported as formal education and friends and neighbours. Similar studies had shown media, (Ahamed et al, 2012) medical professionals (Parey et al, 2010) and friends (Byamugisha et al, 2006) as their main source of information. Less than half of the students (43.7%) knew that they do not need a prescription to obtain ECP. Two- third of the participants knew that they can obtain ECP from pharmacy. In parallel studies pointed out that 78.3% (Ahamed et al, 2012) participants said that they can obtain ECP from health institutions while 65.7% (Parey et al, 2010) stated that they can obtain ECP from the pharmacy.

Less than half (42.5%) of the students knew that ECP was more effective when taken soon after unprotected sexual intercourse. A study conducted in Trinidad reported that 62% knew ECP were more effective when taken soon after unprotected sexual intercourse (Parey et al, 2010). Only 13.7% students knew the correct time gap of ECP which was 12 hours. It seems that majority of the students did not know the correct time gap between the doses. In parallel studies in Iran and India noted that respectively 57.7% (Delaram & Rafie, 2012) and 38.2% (Puri et al, 2007) knew about the correct time gap.

Most of students 71.9% knew that ECP prevents a pregnancy. Majority of the students did not know the effectiveness of the ECP in preventing a pregnancy. In addition to that, majority of the students did not know

whether ECP is more effective than natural methods. Majority (67.8%) of the students did not know how often they can use ECP. Only 6.5% students had ever used ECP. From those who had used ECP 52% had experienced side effects. While 57.5% had not received information on side effects and problems of ECP. Only 7.9% had received information about precautions for side effects of ECP. Similar studies revealed 11.1% (Puri et al, 2007) did not know about the side effects.

Less than half had mentioned that ECP might prevent future pregnancies while in similar studies 31% (Parey et al, 2010) stated that ECP might prevent future pregnancies. In current study, 16.2% had answered that ECP was illegal. Moreover, 13.4% stated that ECP might prevent STIs and HIV.

In current study 45.5% of participants had answered that ECP was important in a situation like post rape. Similar studies were reported that 82.1% (Ahamed et al, 2012) and 32.4% (Puri et al, 2007) respectively from Ethiopia and India ECP was important in a situation like post rape. Less than half 44.8% of the study population had answered that ECP was important as a backup when condom breaks. Above mentioned Ethiopian study reported that, 49.9% (Ahamed et al, 2012) knew the worth of ECP as a backup when condom breaks. In our study 30.9% had answered that ECP was important when oral pills were forgotten. Another study revealed that only 11.1% (Ahamed et al, 2012) thought that ECP was important when oral pills were forgotten. Considerable proportion of respondents 20.2% reported ECP is suitable as preferred contraceptive method whereas ECP was not recommended as a preferred contraceptive method (ICEC,2012).

If ECP should be readily available, 45.8% of students answered that it might promote promiscuity while 13.5% disagreed and majority of the students were unsure. Related studies showed similar outcomes (Parey et al, 2010)(Byamugisha et al, 2006). Present study revealed that majority of the students, 138 (34.9%) agreed to the idea that ECP should be easily accessible. Parey et al in 2010 revealed a similar finding. As our study results indicates majority of the students (32.1%) had an opinion that ECP should be low cost. This is in line with another study (Parey et al, 2010). Very less number of students thought that ECP should only be available for victims of rape, while majority thought it should be available for all. Maximum number of students agreed to the idea that ECP should be available only for women who are over 18 years. This is similar with the study conducted in Trinidad (Parey et al, 2010). The

present study revealed higher number of students (57.7%) responded that they might use ECP in future. In addition to that 43% respondents intended to recommend ECP to a friend or relative. A similar study suggested that only 33.2% (Ahamed et al, 2012) respondents had an intention to use or suggest to a friend or relative.

The current study results on influencing factors for knowledge indicated gender had a significant effect on every aspect of knowledge and attitudes on ECP while, religion did not have a significant effect on any aspect. In addition to that, age, gender and year of study have a significant effect on knowledge on ECP. Apart from that, it was found that gender, year of study, and department played a major role as influencing factors on attitudes.

## V. CONCLUSION

According to the present study finding it can be concluded, the awareness on ECP is at a considerable level. However, there were many misconceptions on knowledge, to illustrate, most of the students stated that ECP can be used as a preferred contraceptive method. Most of the attitudes on ECP were towards positive. Even though, it was found from the present study that undergraduates had heard about ECP through formal education, they did not have a sufficient knowledge on ECP.

Therefore, it is recommended that health professionals should step in and interfere with current issue and provide sufficient knowledge to youth. In addition to that, undergraduates had negative attitudes towards ECP. Therefore, it is necessary to change attitudes on ECP.

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# *Computing*

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“Resolutions for Challenges & Opportunities of  
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# ICT TO IOT HOW TO KEEP UP WITH FAST MOVING INFORMATION TECHNOLOGIES

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The dawn of information age has driven us to in imaginable innovations based on technology – innovations not only of products and services, but also strategies and policies. When one take into account of the time that telephone was invented by Mr. Bell, it took almost 100 years to see major changes to the way information was generated and used. However, the emergence of computers, particularly, the personal computer, and the Internet dawned an era of rapid innovations resulting in iPhones and now IoTs (Internet of Things). Everything one can possibly think of, from autonomous diving, artificial intelligence, social media, to GPS in space, the information has taken over our lives. So far the “haves” or the so-called developed countries have

been the main beneficiaries of fast moving information age. With predictions of billions of IoTs to populate the world, there is a great danger of “IoT Divide” taking place between “haves” and “have-nots”. This makes it vital for countries such as Sri Lanka to plan new ICT strategies in order to tap into reap the benefits of new information age. The aim of this presentation is to highlight the strategies and options that are still out there for countries such as Sri Lanka to explore.

**ONLINE LEARNING:  
COMMON CHALLENGES FOR  
INSTRUCTORS IN LARGE  
ONLINE COURSES:  
STRATEGIES TO MITIGATE STUDENT  
AND INSTRUCTOR  
FRUSTRATION**

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Teaching in the online classroom is becoming commonplace for instructors as universities seek to grow enrolments and tap into unexplored markets. Many instructors, however, are often unprepared for the nuances of distance education and apprehensive about making the transition to online learning. This presentation aims to discuss basic principles of online learning, advantages and disadvantages compared to face to face learning, common challenges for instructors of high-enrolment online courses. Those challenges align with the areas students commonly consider as necessary for successful online delivery. Using examples from large online classes

and the existing research on best practices in online education, ways to minimize those challenges will be discussed. These suggestions include recommendations for assignment construction, including the use of group work, collaborative assignments, e-portfolios, as well as for planning course design, including consistent deadlines and course structure. These suggestions are aimed at mitigating student and instructor frustration with high enrolment online classes.

# BITCOINS ARE HERE TO STAY: ARE WE READY?

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Bitcoin is a cryptocurrency that is not under control of any single authority or an organization. All the bitcoin transactions are recorded in a public, distributed ledger. The bitcoins exist in this ledger as chains of transactions. This ledger is represented as a chained collection of blocks-of-transactions. A bitcoin miner adds a cryptographic hash to a block and once this hash is accepted by a majority of nodes in the network, it is extremely hard (almost impossible) to change the recorded transactions. Huge amount of computing power has to be spent by the miner to calculate this cryptographic hash. However, once this hash is calculated it is extremely simple to verify that it is indeed a valid hash. This hash is a proof that the miner has spent sufficient computing power to protect a block and as a reward for that work the miner gets new bitcoins. This is the only way new coins can be minted in the bitcoin

system. As time goes on mining becomes harder and harder and the rate at which the bitcoins enters into the system goes down. This is how the bitcoin system controls the money supply without a central bank. The owners of bitcoins are not really people or organizations, but public/private key pairs. Therefore, bitcoins provide certain level of anonymity to transactions. This anonymity can be further enhanced by techniques such as bitcoin mixing. There are more than 3 million unique users of bitcoins and more than 100,000 organizations accepts bitcoins for payments worldwide. Are Sri Lankan organizations, law enforcement, security establishment, and regulators ready to face the challenges and opportunities in this new economic environment?

# ANALYTICS AND AI: THE GOOD, THE BAD AND THE UGLY

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Analytics let us question the data, which in effect questions the world around us. This let us understand, monitor, and shape the world. AI let us discover connections, predict the possible futures and automate tasks. These twin technologies can change the world around us. On one hand make us efficient, connected, and fulfilled. At the same time, the change of status quo can replace jobs, affect

lives and build biases into our systems that can marginalize millions. In this talk, we will discuss core ideas behind analytics and AI, their possible impact, both good and bad outcomes, and challenges.

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*Technical  
Session*

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(ORAL & POSTER PRESENTATIONS)

# SINHALA SPEECH TO TEXT LIBRARY USING SPHINX

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**Abstract** – Speech-to-text has generated a tremendous interest in the field of Natural Language Processing where the ultimate goal is to build applications and systems that has the capability to respond to the natural languages that us humans use in a daily basis. Converting speech to text using European languages has emerged in the world and can be found in most modern electronic devices. But a speech-to-text tool for the native language of Sri Lanka which is “Sinhala” is rare to find. So, developing a STT algorithm for Sinhala to implement an application would help most of the local workforce for their day-today tasks and for the development of the software industry with a unique Sri Lankan touch. STT has become one of the best used technologies in the modern world. It has caught the attention of the public as it is an excellent user-friendly feature that has been embedded to electronic devices in the modern world. It too has caught the attention of the organizations as they can develop much better and attractive devices which can rise in the competing market. Personal Computers, Hand-held smart devices and even modern automobiles come pre-integrated with STT for the convenient of the user and give them a better experience.

**Keywords** – Speech-to-Text, Sinhala, Sphinx4

## I. INTRODUCTION

Speech-to-text has become an interesting phenomenon in the modern world. Various types of end devices such as Personal Computers, Hand held smart devices and even modern automobiles come integrated with this feature for the convenience of the end user. One of the basic stages of

these advance voice recognition systems is the recognition of words spoken by a human being or in other words, natural language recognition. These algorithms can identify words spoken by a user, cross reference the words through a word dictionary for validation and generate an output to the user. It is an alternative to typing on a keyboard and this is something that exists today in smartphones where one of the most known application is “Siri”(“Apple - iOS - Siri,” 2015) for Apple products and “Google Now”(“Google now,” 2015) for devices running on Android OS. Speech recognition will be more and more common in the future as the amount of data grows and devices contain more features.

Speech-to-Text software programs work by analyzing sounds and converting them to text. This software has been developed in a way to provide a faster method of writing on a computer and can help people with a variety of disabilities. It is useful for people with physical disabilities who often find typing difficult, painful or impossible. Speech-to-Text software can also help those with spelling difficulties, including users with dyslexia, because recognized words are almost always correctly spelled. There some major researches in the field. The first one is a CMU SPHINX-4 SPEECH RECOGNITION SYSTEM done by eight personals in different four institutions. They are Carnegie Mellon University, USA, University of California, Santa Cruz, USA, Sun Microsystems Laboratories, USA and Mitsubishi Electric Research Labs, USA. They have done a marvelous research as joint development. There are some significant features of the Sphinx-4 decoder. It is highly modular and flexible,



supporting all types of HMM-based acoustic models, all standard types of language models, and multiple search strategies. Algorithmic innovations in the system enable the concurrent use of multiple information streams. The Sphinx-4 system is an open source project. The code has been publicly available at SourceForge™ since its inception. The design, results, and team meeting notes are also publicly available.

vietnam national university, the international university school of computer science and engineering have introduced a good method of identifying the words using the phonetics. The words to be identified should be broken down to its phonetics. As an example, for the following two Sinhala words can be encoded as,

e.g.: මගේ - M AH G EH  
නම - N AH M AH

So, by using this concept we have made a gram file for Sinhala language. We have put some frequently used words in the Sinhala language, generated their phonetic scheme as above and created a grammar file. There is a need of a good accurate application for Speech Recognition regarding Sinhala language. So, we thought of developing a library for Sinhala language that can be edited for many purposes. We thought of making it as an open source library so that various people can make contributions to developing it and thereby make use of it to address Sinhala speech-to-text requirements.

### III. PROBLEM AND OBJECTIVE

The problem at hand is that there is a need for a good and accurate Speech-to-text application for Sinhala language. And there is a need for a text library for Sinhala language so that it can be used inside other applications to convert spoken Sinhala words to Sinhala text. Our main objective in this research was to study and develop a language model and an acoustic model for the Sinhala language which results in a language model file and a dictionary file which includes the phonetics of the Sinhala word pronunciation which can be used as an externally pluggable library to any application.

### IV. SOLUTION

The solution to the above-mentioned problem is to develop a library package which can convert spoken Sinhala words to Sinhala text. This can be accomplished by making modifications to the opensource library Sphinx4(“Sphinx-4 - A speech recognizer written entirely in the Java(TM) programming language,” 2015) and there by compiling a bunch of library files that can be directly imported an application development environment. Speech is a complex phenomenon of which people rarely understand how it is generated and perceived. The general conception is that speech consists of words and each word consists of phones which happen to be the building blocks (phonetic schemes) of the word pronunciation.

Most modern speech recognition systems are mainly based on probability theories. That means that there are no certain boundaries between units, or between words. Speech to text translation and other applications of speech are never completely correct. Speech consists of a continuous wave form comprising stable states mixed with dynamically changing states. Within these sequences, we can define similar components of sounds called phones. A single word is said to be built from phones. Context, speaker, style of speech, dialect can be factors which would change the acoustic properties of a waveform. Transitions between words are more informative than stable regions, developers often talk about diphones - parts of phones between two consecutive phones. Sometimes sub phonetic units (different sub-states of a phone) are also considered. In a considered phone there can be identifiable three states, namely preceding phone, middle part & subsequent phone. Phones that are considered in context are called triphones or quinquaphones.

The recognition process is undertaken by taking the waveform, split it on utterances by silences then try to recognize what's being said in each utterance.

### V. DESIGN

Speech-to-text modules and libraries have been proliferating in the technological arena and they tend to gain traction much more as it is a user-friendly mode of interaction between the user and a computer. The method that these efficient algorithms use is a statistical analysis of the probability of a word that can appear in a recorded voice based on the array of words spoken before that specific word. There was no considerable success in the

field of speech recognition until Lenny Baum of Princeton University invented the Hidden Markov Model (HMM) which provided a statistical based model to generate text from speech. From that point, onwards many corporations have used this model to develop their own speech recognition systems.

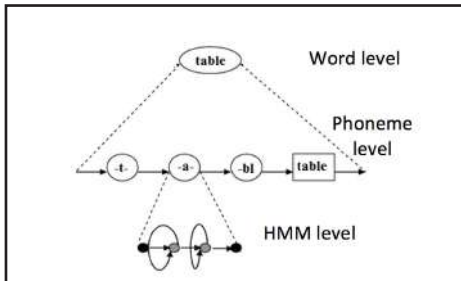


Figure 1 : Breakdown of words to phonemes

A group of scientists from the Carnegie Mellon University, Sun Microsystems Laboratories, Mitsubishi Electric Research Labs, Hewlett Packages and contributors from University of California and Massachusetts Institute of Technology have built a well-known speech recognition framework written in Java programming language called the Sphinx4 Framework. (“CMU Sphinx,” 2015, p. 4) Sphinx4 is a speech recognition system based on HMM which is a precise mathematical framework. The ability to use pluggable modules in the Sphinx4 framework makes it more flexible and easy to adopt. Hidden Markov Model (HMM) is a statistical model in which the system being modeled assumed to be a Markov process with unknown parameters, and the challenge is to determine the hidden parameters from an observation parameters. In speech recognition process, after the user’s voice is recorded, it will be divided into many frames that we need to process to generate the sentence in text form. Each frame is represented as a state, group of some states is represented as phoneme, and group of some phonemes is represented as word that we need to recognize. In database known as linguist model, we store the reference value of state, phoneme, and word to compare with the observed data (voice).

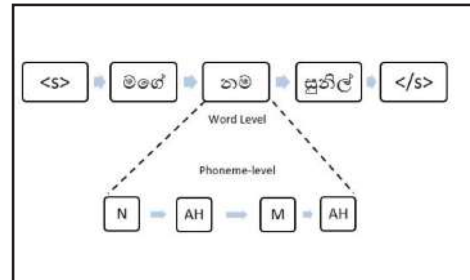


Figure 2: Phoneme breakdown for Sinhala

Table 1: Breakdown of Sinhala words to phonetic scheme

Word	Phoneme
මගේ	M AH G EH
නම	N AH M AH
සුනිල්	S UH N IH L

The above illustration depicts how a word can be subdivided into its phones. The Sinhala word “නම” is basically comprised of 4 phones according to which a human being pronounces it. The table shows the phone building blocks for some other simple Sinhala words. Notice the tags “<s> </s>” which are the opening and closing tags of a series of Words in the dictionary (.dict) file. (“Vietnamese Language Recognition with Sphinx4 | Khai Tran - Academia.edu,” 2015)

## VI. PHONETIC SCHEME ALGORITHM

For the Speech-to-text conversion using the Sphinx4 library, the phonetic schemes of the Sinhala words should be recorded in a dictionary file which resides inside the compiled jar file of the Sphinx4 library. These phonetic schemes are the basic auditory units that build up a single word. The Sphinx4 library already has a built-in dictionary file that comprises of English words and their corresponding phonetic schemes. But for Sinhala words to be recognized, the Sinhala words along with the corresponding phonetic scheme (as shown in Table 1).

Through a thorough analysis and testing of the dictionary file for the English words, we identified the phonemes in the lower level that corresponds to various pronunciations. There by, we could map the English phonemes to Sinhala words depending on how the words are pronounced.

- සිංහල S IH NG
- මගේ M AH G EH
- නම N AH M AH
- සුනිල් S UH N IH L
- රච R AH T AH
- ඔබන්න OW B AH N N AH
- හරි HH AH R IY
- නිවැරදි N IH W AH R AH D IY
- යන්න Y AH N N AH
- එන්න EH N N AH
- ඔබ OW B AH
- පිටුවහල් P IH T UH W AH HH AH L

The phonetic scheme algorithm that we have developed, will decompose a given Sinhala word to its phonetic scheme as follows.

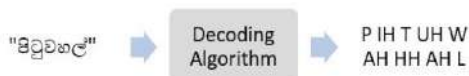


Figure 3: Phonetic scheme algorithm architecture

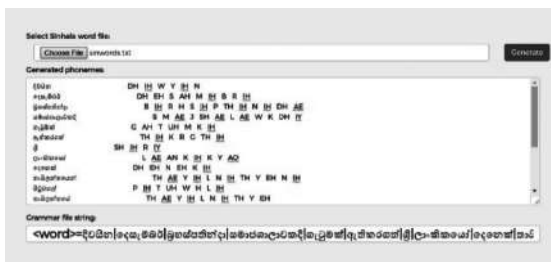


Figure 4: Algorithm implementation

The below figure will show an example for the Sinhala letter “ක” and its transformations and the relative phonetic scheme for each of those combinations.

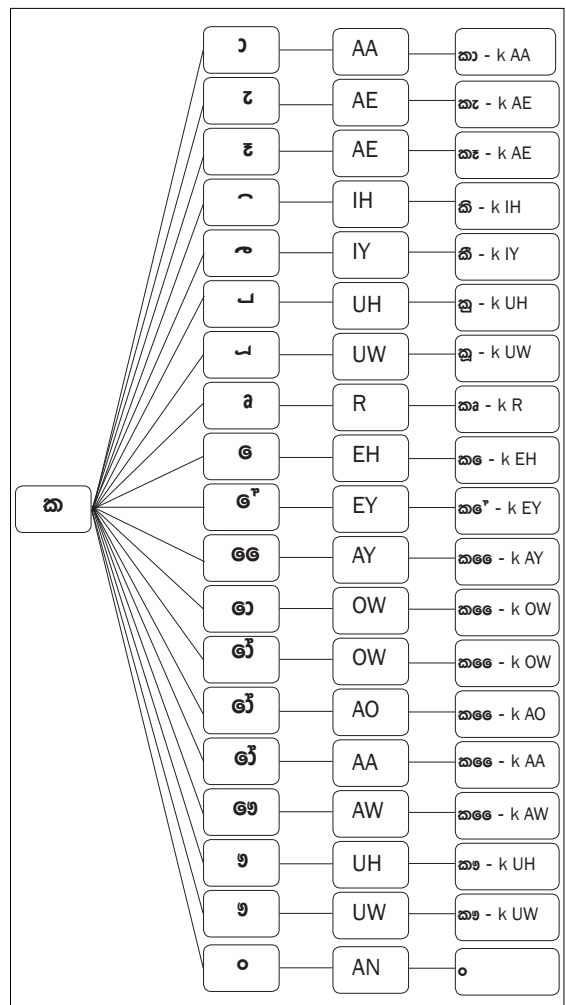


Figure 5: Formations of phonemes

## VII. IMPLEMENTATION

### i. Sinhala Speech-to-Text sample application

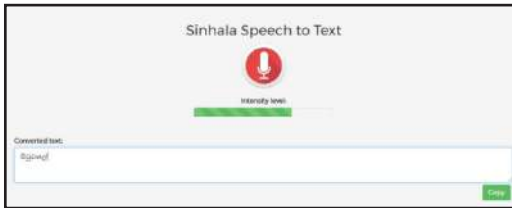


Figure 6: Sinhala speech-to-text application

This application takes the input from the microphone and using the phonetic scheme above, recognizes the word and displays it to the user. This above shown is an example of the recognized word “පිටුවක” spoken through the microphone.

### ii. The Web Browser

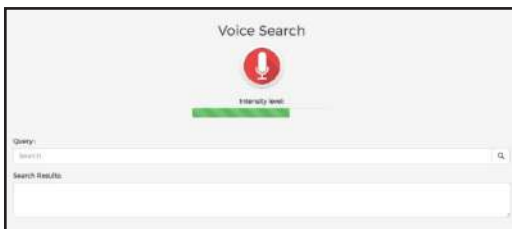


Figure 7: Sinhala voice search browser

This is a browser powered by the Google Search API[10] and completely works with Sinhala words recognized using voice, which are passed to as a search phrase to the google search engine which in turn, returns the search results as a Json object. The google Gson helps to decode the Json object to separate the titles and the URLs of the returned results. Those results can be seen in the large textarea in the above figure.

## VIII. EVALUATION

The recognition performance evaluation of the system must be measured on a corpus of data. A separate test corpus, with new Sinhala words, was created from the main corpus. The test corpus was made of 200 recorded and labelled data. In order to test for speaker independency of the system, some of the subjects who participated in

creation of the testing corpus had not participated in creation of the training corpus.

We have analyzed 200+ words and the data statistics are as follows:

The average word identification rate for the tested data set is 65.84% with a variance of 1000.961 and a standard deviation of 31.63797.

## IX. CONCLUSION

With the proliferation of Speech-to-text technology, it's clear that it has become an essential technology in almost every electronic device. So here our attempt was to develop a system and a library to handle voice recognition in Sinhala language. We used the CMU Sphinx4 library to achieve this task. The Sphinx4 library consists of a grammar file which contains English words and their corresponding phonetic schemes. Those phonetic schemes are mapped to various word pronunciation blocks. This research used those blocks and mapped them to the pronunciation patterns of the Sinhala words available in the selected data set. There by we could develop a Sinhala speech-to-text library which can detect a spoken Sinhala word, cross refer it with the existing data base and if the word is available then will give a text output of the spoken word. The final output of the research is a java library that can be downloaded and used to any other application development process. The issue that we faced was to improve the word detection percentage to a much higher level. The reason for that would be the fact that Sphinx4 library was originally designed to adhere to the dialect of Europeans. Since the pronunciation of Asians and specifically Sri Lankans is different, the decoder finds it difficult to identify the dialect. Therefore the word recognition rate is lower.

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APPENDIX A

Word	Phoneme
අ	AH
ආ	AA
ඇ	AE
ඈ	AE
ඉ	IH
ඊ	IY
උ	UH
ඌ	UW
එ	EH
ඒ	EY
ඓ	AY
ඔ	OW
ඕ	OW
ඖ	AW
ක	K
ග	G
ච	CH
ඡ	CH
ඣ	JH
ට	T
ඩ	D
ණ	N
න	N
ත	TH
ද	DH
ප	P
බ	B
භ	BH
ම	M
ය	Y
ර	R

ල	L
ව	W
ෂ	SH
ශ	SH
ස	S
හ	HH
ළ	L
ඟ	F
ඞ	
ඹ	AA
ය	AE
ර	AE
඼	IH
ල	IY
඿	UH
ෆ	UW
෇	R
෈	EH
෉	EY
්	AY
෋	OW
෌	OW
෍	AW
෎	UH
ා	UW
ැ	AN

# KEYXTRACT TWITTER MODEL - AN ESSENTIAL KEYWORDS EXTRACTION MODEL FOR TWITTER DESIGNED USING NLP TOOLS

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**Abstract** - Since a tweet is limited to 140 characters, it is ambiguous and difficult for traditional Natural Language Processing (NLP) tools to analyse. This research presents KeyXtract which enhances the machine learning based Stanford CoreNLP Part-of-Speech (POS) tagger with the Twitter model to extract essential keywords from a tweet. The system was developed using rule-based parsers and two corpora. The data for the research was obtained from a Twitter profile of a telecommunication company. The system development consisted of two stages. At the initial stage, a domain specific corpus was compiled after analysing the tweets. The POS tagger extracted the Noun Phrases and Verb Phrases while the parsers removed noise and extracted any other keywords missed by the POS tagger. The system was evaluated using the Turing Test. After it was tested and compared against Stanford CoreNLP, the second stage of the system was developed addressing the shortcomings of the first stage. It was enhanced using Named Entity Recognition and Lemmatization. The second stage was also tested using the Turing test and its pass rate increased from 50.00% to 83.33%. The performance of the final system output was measured using the F1 score. Stanford CoreNLP with the Twitter model had an average F1 of 0.69 while the improved system had a F1 of 0.77. The accuracy of the system could be improved by using a complete domain specific corpus. Since the system used linguistic features of a sentence, it could be applied to other NLP tools.

**Keywords** - Natural Language Processing, Stanford CoreNLP, Tweet Analysis, Named Entity Recognition, Lemmatization, Keyword Extraction, Turing Test

## I. INTRODUCTION

Natural Language Processing (NLP) has seen unprecedented development over the past two decades (Zitouni, 2014). Keyword extraction of NLP is used during Question and Answering (Q&A) processes.

In understanding a question, humans extract keywords that are vital in synthesizing the answer. These specific words can also be used to back-formulate the question. In NLP, POS tags could be used to extract key ideas from a sentence.

One of the most fertile grounds to put NLP to test is Twitter. A tweet might be ambiguous and is not always grammatically correct. Hence, conventional POS tagging methods cannot be used to extract keywords from a tweet. Corporate giants often answer customer support requests through Twitter, which has 320 million active users per month (Twitter Usage / Company Facts, 2016). In Sri Lanka, Dialog Axiata is a prominent telecommunication company that provides this service. Automating this process is challenging for a machine, as interpreting a tweet could be problematic.

This research presents KeyXtract which is a new utilization of the Stanford CoreNLP (Manning et al., 2014) tool, a widely used machine learning based NLP tool. The research was conducted in two stages. The Twitter Model for KeyXtract presented in this paper is the extension of Stage 1 developed at the first stage of the research. In the first stage (Weerasooriya, Perera and S R Liyanage, 2016), Stanford CoreNLP was enhanced using parsers (to extract essential keywords using the linguistic features of a sentence) and a domain specific corpus (consisting of 206 words). The second stage presented in this paper consists of improvements made based on the evaluation results of stage 1. The Turing test was used to evaluate the success of this method in imitating the human logic, and its performance was measured using the F1 score.

## II. RELATED WORK

### A. Extracting keywords

Mitkov and Ha, state that to extract a “ ‘keyword phrase’, a list of semantically close terms including a noun phrase, verb phrase, adjective phrase and adverb phrase” (Mitkov and Ha, 1999) should be considered. In the current study, Noun Phrase (NP) and Verb Phrase (VP) are used in keyword extraction.

### B. Current tools in NLP and POS Tagging

Currently, Stanford CoreNLP (version 3.6.0) (Manning et al., 2014), Open NLP (version 1.6.0) (Welcome to Apache OpenNLP, 2013) and NLP4J (version 1.1.3) (emorynlp/nlp4j: NLP tools developed by Emory University, 2016) are the widely used machine learning based Open Source NLP tools for Java. These are the NLP tools with the highest level of accuracy. The NLP tool named ANNIE POS tagger (included with GATE, version 8.2) (Cunningham et al., 2001) uses a rule-based approach in contrast to machine learning methods. The present research employs a machine learning based approach of NLP tools.

POS tagging is done using Tregex (Levy and Andrew, 2006) method and the Penn Treebank notation (Marcus et al., 1994) is used to POS tag each word. In both cases, the tagger uses the unidirectional model, where the tag of the current word is predicted based on the tags of its neighbours. A dependency network is used to perform this task, and a word is considered as a node in the network which is directly influenced by its neighbours (Toutanova, Klein and Manning, 2003). POS tagging is made use of in the current study, to identify the keywords of a tweet.

### C. Lemmatization

Lemmatization uses “the vocabulary and morphological analysis of words”, normally aiming “to remove inflectional endings only and to return the base or dictionary form of a word, which is known as the lemma” (Manning, Ragahvan and Schutze, 2008, p. 32). For example, this technique is used to obtain the common root “eat” from the following list.

E.g.; The lemma of ‘eats’, ‘eating’ and ‘eat’ is ‘eat’

Another similar technique of obtaining the root is through stemming. (Manning, Ragahvan and Schutze, 2008, p. 32). In this research, the Lemma is used to expand and isolate the subject and the verb in a subject-verb contraction. Stanford CoreNLP Suite (Stanford Named Entity Recognizer (NER), no date) comes with the Lemma bundled which is used for this study.

### D. Named Entity Recognition (NER) and NLP

NER is used to extract relevant information from a text and sort them into classes. The NER (Finkel, Grenager and Manning, 2005) included in the Stanford CoreNLP suite has the ability to label words into a 7-class model. The 7 classes consist of location, person, organization, money, percent, date and time (Stanford Named Entity Recognizer (NER), no date). The NER utilizes the POS tag and lemma of a word to assign a class into it. The class of a word is also used in this study to identify keywords

### E. Use of NLP in Twitter

As tweets are limited to 140 characters, they tend to “exhibit much more language variation. (Bontcheva et al., 2013). This is one reason why previous researchers state that tweets cannot be analysed using basic POS tagging (Bontcheva et al., 2013). Several attempts such TwitIE (Bontcheva et al., 2013) and TweetNLP (Owoputi et al., 2013) have been made to develop models to analyse POS tags of Tweets, but with limited success. In the Twitter-POS tagger model released for Stanford CoreNLP (Derczynski, Ritter, et al., 2013), some of the aforementioned functionalities have been incorporated. However, there is a need for developing accurately modelled domain specific corpora, for the analysis of POS tagging in Tweets.

In the present study, “rule-based grammars for the syntactic-semantic analysis of word forms and sentences” (Hausser, 2014) is applied to extract the relevant keywords from the tweets.



**F. Turing Test and NLP**

The Turing Test (Turing, 1950) introduced by Alan Turing in 1950 is conducted to answer the question, “Can Machines Think?” (Copeland, 2004, p. 479). Thus, according to Turing, “any machine that plays the imitation game successfully can appropriately be described as a brain” (Copeland, 2004, p. 479). The participants of the test are a human respondent, a human evaluator and the machine. The test is conducted by asking a question from the human respondent and the machine, then the human evaluator is asked to identify the machine generated response out of the responses from the human and the machine (Turing, 1950; Witten, Bell and Fellows, 1998). If the human is unable to identify more than half of the machine generated responses, the machine passes the Turing Test (Witten, Bell and Fellows, 1998). Since the objective of this research is to enable the machine to imitate a human, the Turing Test was used as the method of evaluation.

**G. The Present Research**

This research was developed in two stages. The research is the extension of Stage 1 of the system.

- 1) Stage 1: This stage extracted the keywords by considering the noun phrase (NP) and verb phrase (VP). The keywords were then sent through a parser to remove any linguistic and domain specific noise, followed by another parser to include any domain specific words that were not extracted from the tweet. The method was evaluated using the Turing Test which consisted of a sample of 6 pairs (Weerasooriya, Perera and S.R. Liyanage, 2016).
- 2) Stage 2: The second stage addressed the shortcomings of stage one. The improvements needed were identified by comparing the machine generated responses and the human generated responses of stage 1.

**III.METHODOLOGY**

The process of developing the stages 1 and 2 is mentioned below.

**A. Data Collection and Development of the Corpora**

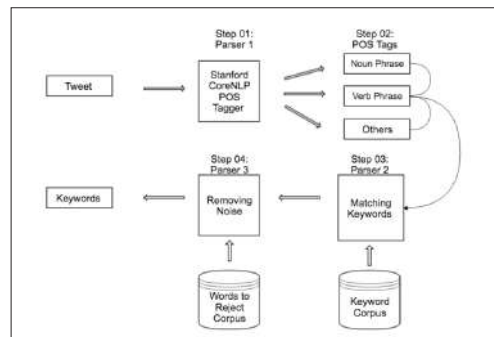
The Dialog Axiata (Dialog Axiata (@dialoglk) | Twitter, no date) Twitter profile was used to build the system. Two corpora were built by analysing the tweets. Terms that refer to Dialog Axiata and its services are identified as Domain Specific Keywords (DSK). The corpus of DSK was manually collected by analysing tweets from the month of February, 2016 to March, 2016. The corpus contained 206 words.

The domain specific ‘words to reject’ corpus consisted of words that do not contribute to the meaning (E.g. hello, hi, dear), interjections that are often wrongly tagged as verbs (E.g. please, thanks), certain nouns, verbs, and auxiliary verbs. This corpus consisted of 70 words.

**B. NLP and POS Tagger**

A machine learning-based POS tagger was selected for this research, as it has the ability to “exploit labelled training data to adapt to new genres or even languages, through supervised learning” (Derczynski, Ritter, et al., 2013). The highest token accuracy of 97.64% is recorded by NLP4J (Nanavati and Ghodasara, 2015; POS Tagging (State of the art), 2016). However, this accuracy is at stake in Twitter analysis. As a result, the token accuracy of the POS tagger declines from 97-98% to 70-75% (Derczynski, Maynard, et al., 2013).

A POS Tagger model specifically trained for tweets displayed a token accuracy to 90.5% (Derczynski, Ritter, et al., 2013). Out of the above mentioned list of tools,



**Fig. 1 Flow Chart of Stage 1**

this model was available only for Stanford CoreNLP (Derczynski, Ritter, et al., 2013). Hence, Stanford CoreNLP was used for the present research.

The flow chart of the methodology for Stage 1 which was developed in 2016 (Weerasooriya, Perera and S.R. Liyanage, 2016) is shown in Fig 1.

**C. Stage 2: System Design**

The result of Stage 1 for an example tweet is given below. Tweet - @dialoglk I made my payment just after my line got barred in themorning! And still the line hasn't got connected, Whats with the delay?

**Keywords – made (VBD), payment(NN), line(NN), got(VBD), barred(VBD), morning(NN), line(NN), got(VBD), connected(VBN), delay(NN)**

(Abbreviations of the Penn Treebank Notation (Marcus et al., 1994):

CC – Coordination Conjunction, CD – Cardinal Number, DT – Determiner, IN – Preposition or subordination, JJ – Adjective, NN – Noun, Singular or Mass, VB – Verb, base form, VBD – Verb, past tense, VBN – Verb, past participle, VBZ – Verb, 3rd person singular present, PRP - Personal Pronoun, PRP\$ - Possessive Pronoun, RB – Adverb,USR – Username, WP – Wh-pronoun)

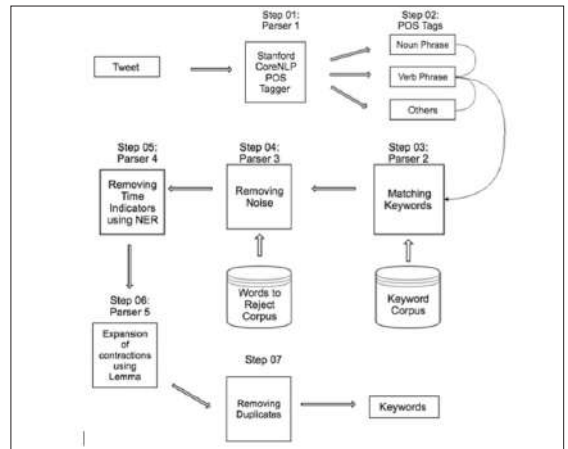
The lapses identified from Stage 1 are as follows:

- i. Unnecessary time indicators included– The word “morning”
- ii. Contractions not expanded– Contractions such as “ve” and “n’t”
- iii. Negation markers absent– The word “hasn’t”
- iv. Duplicate Keywords not removed– Repetition of the word “got”

The above issues were addressed using the following methods:

- i. NER - To identify and remove time indicators.
- ii. Lemma – To expand and analyse the contractions.
- iii. Adverbs – To include negation markers
- iv. LinkedHashSet – To remove duplicates

Stage 2 was also evaluated using the Turing Test and the results were recorded. Flow chart of the improved system is shown in Fig. 2.



**Fig. 2 The Flow Chart of the Improved System**

**D. Parser 4 - NER and Time Indicators**

The time indicators are, in most cases, not essential for the meaning and were not present in the human generated keyword sets. Thus, using NER, the time indicators such as “morning” were removed in the system revision. The result of the Parser 4 is shown in Fig. 3.

Tweet - @dialoglk I made my payment just after my line got barred in the morning! And still the line hasn't got connected, Whats with the delay?

**Verbs - made(VBD), got(VBD), barred(VBN), ~~has(VBZ)~~, got(VBD), connected(VBN)**

**Nouns - payment(NN), line(NN), ~~morning(NN)~~, line(NN), delay(NN)**

**Other - @dialoglk(USR), I(PRP), my(PRPS), just(RB), after(IN), my(PRPS), in(IN), the(DT), and(CC), still(RB), the(DT), n't(RB), whats(WP), with(IN), the(DT)**

**Fig. 3 The result from Parser 4**

**E. Parser 5 – Expansion and Analysis of Contractions**

As lemma gives the common root of a word, it was used to expand and analyse contractions. In the example (Fig. 3), the contraction “hasn’t” is expanded to “has” (VBZ) and “not” (RB) through lemmatization. However, “has” is rejected as it is an auxiliary verb (see Parser 3). The result from Parser 5 is shown in Fig. 4.

Tweet - @dialoglk I made my payment just after my line got barred in the morning! And still the line hasn't got connected, Whats with the delay?

**Verbs - made(VBD), got(VBD), barred(VBN), ~~has(VBZ)~~, got(VBD), connected(VBN)**

**Nouns - payment(NN), line(NN), ~~morning(NN)~~, line(NN), delay(NN)**

**Other - @dialoglk(USR), I(PRP), my(PRPS), just(RB), after(IN), my(PRPS), in(IN), the(DT), and(CC), still(RB), the(DT), ~~not(RB)~~, whats(WP), with(IN), the(DT)**

**Fig. 4 The result from Parser 5**

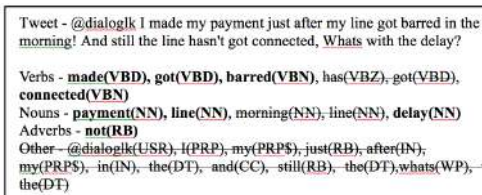
## F. Adjustment of Parser 1 – Negation Markers (Adverbs)

The negation markers such as ‘not’ from Parser 5 are identified as adverbs. When the lemma of the contractions from Parser 5 separated the ‘not’ from the rest of the verb, the word ‘not’ is included back into the keywords list as it is important for the meaning.

## G. Removing Duplicates

he keyword list shown in Fig. 4 consists of duplicates such as “got”. This was removed from the final keywords list by using a LinkedHashMap, which does not allow duplicates, while retaining the sequential order in the list.

**Keywords – made(VBD), payment(NN), line(NN), got(VBD), barred(VBD), line(NN), not(RB), connected(VBN), delay(NN)**



Tweet - @dialogkk I made my payment just after my line got barred in the morning! And still the line hasn't got connected, Whats with the delay?

Verbs - **made(VBD), got(VBD), barred(VBN), has(VBZ), got(VBD), connected(VBN)**

Nouns - **payment(NN), line(NN), morning(NN), line(NN), delay(NN)**

Adverbs - **not(RB)**

Other - @dialogkk(USR), I(PRPR), my(PRPS), just(RB), after(IN), my(PRPS), in(IN), the(DT), and(CC), still(RB), the(DT), whats(WP), the(DT)

*Fig. 5 The final resulting keyword list*

## IV. RESULTS AND DISCUSSION

The system (also referred as the ‘machine’ in this section) was evaluated with and without improvements. The system without modifications is the Stanford CoreNLP (Manning et al., 2014) with the Twitter model (Derczynski, Ritter, et al., 2013). The system with modifications is the system presented in this research and it is tested against the Stanford CoreNLP with the Twitter model. The three systems are referred to as follows in the rest of the paper.

System A : Stanford CoreNLP with the Twitter model  
 System B : Stage 1 of the machine  
 System C : Stage 2 of the machine, KeyXtract

The systems were evaluated using two methods as follows,

- Turing Test – To evaluate if the machine could successfully imitate human logic.
- Performance Test – To evaluate the performance of keyword extraction by the machine. This was measured using the F1 Score (Derczynski, 2013).

The Turing Test involves asking a set of questions from a human and the machine. Their answers are then evaluated by a human supervisor. If the supervisor is unable to identify the machine in at least half of the test cases, the machine passes the Turing Test (Turing, 1950). The testing was conducted in three phases,

- To evaluate System A.
- To evaluate System B.
- To evaluate System C.

The performance was measured by comparing the keywords sets generated by the machine with two keywords sets produced by an English language expert and an author of the research. The human generated keyword sets were compared with the System A and System C using the F1 Scores. This was used to measure the performance of the machine.

### A. Turing Test: Evaluation Methodology: Design

The evaluations based on the Turing Test were conducted for each system as mentioned above. The System A and System B were tested with the same set of supervisors with a time gap of 3 months between the tests. This time gap was to ensure the responses would not be fresh in the minds of the human participants. Since the System C was improved considering the previous responses, it was tested with a new set of supervisors.

### B. Turing Test: Evaluation Methodology: Participants

All three systems were tested with six test cases (each consisting of the machine, the human keyword generator and a human supervisor). The human participants in the six test cases were chosen to represent six different fields. The criteria of the test cases are given in Table I.

Keywords sets were produced by the human and the machine, and the human supervisor tried to identify the system generated answers.

### C. Turing Test: Evaluation Methodology: Keyword Extraction

The testing dataset consisted of 14 tweets (2 tweets per day collected for 7 days). They were collected from the first week of April, 2016 (3rd April to 9th April). The dataset contained a new set of tweets. The set of tweets were given to the human keyword generators to extract keywords and

then to the machine to do the same. This was repeated for Systems A, B and C.

**Table I - Test case criteria**

Test Case Number	Test Case Criterion	Justification	Minimum Requirement
1	Academics	Frequent users of Academic English	University lecturers who are not from the field of English
2	English Language Experts	Competent in English language and literature	English Language Lecturers
3	Undergraduates	Use English for academic purposes	Individuals currently reading for a Bachelor's degree
4	Graduates	Use English in a professional context	Individuals who have completed a Bachelor's Degree
5	Computer Science Graduates	Have an expert knowledge in Computer Science	Computer Science graduates working in the industry
6	Randomly selected twitter users	Being Familiar with Twitter	Twitter Users

**D. Turing Test: Evaluation Methodology: Evaluation of Test Cases**

The responses generated at the extraction phase by the human keyword generators, the Systems A, B and C were used in this stage.

In the first round, the supervisor was provided with the original tweet and the two sets of keywords generated by the System A and the human. The supervisor was asked to identify the set of keywords which was generated by the System A (the machine).

The same process was repeated with the keywords sets generated by the human and System B, and the human and the System C. System C was tested last with a group of fresh supervisors who were completely new to the research.

**E. Turing Test: Evaluation Discussion: Identical Keyword Extraction**

During the keyword extraction phase, all three systems produced several keyword sets which were identical to the responses of the human.

An example for this occurrence is given below, “@dialoglk Where i can buy a touch travel pass?”

Machine Generated Keywords - buy, touch, travel, pass  
 Human Generated Keywords - buy, touch, travel, pass  
 Among System B, and C, 5 tweets out of 14 had keyword sets where the answers of the human and the System were identical.

**F. Turing Test: Evaluation Discussion: Results**

A summary of the overall evaluation results is given in Tables III (for System A), Table IV (for System B) and Table V (for System C). The total instances where the machine was successful was calculated using the given formula.

$$T = \left( \frac{x + z}{n} \right) * 100\%$$

where,

- T - Total instances where the system was successful
- x - Instances where the Machine and Human answers are identical
- z - Instances where the Supervisor did not detect the answer generated by the Machine
- n - Total number of tweets

Evaluation Results of System C is shown in Table II.

**Table II - summary of turing test applied for system c: stage 2 of the machine**

Test Case Criterion	Machine and Human answers were identical (x)	Supervisor detected the answer generated by the Machine (y)	Supervisor could not detect the answer generated by the machine (z)	Total instances where the system was successful (T)
Academics	0	11	3	21.43%
English Language Experts	0	4	10	71.43%
Undergraduates	4	8	2	85.71%
Graduates	4	7	3	50.00%
Computer Science Graduates	4	3	7	78.57%
Randomly selected twitter users	5	5	4	64.29%

The machine was unsuccessful only with academics, this could be due to their familiarity with analytical and technical writing.

An overview of the Turing test results is shown in Table III.

**Table III - comparison of the turing test results**

System Tested	Test cases that passed	Test cases that failed	Success rate of the System
<b>System A: Stanford CoreNLP with the Twitter model</b>	3	3	50.00%
<b>System B: Stage 1 of the machine</b>	5	1	83.33%
<b>System C: Stage 2 of the machine</b>	5	1	83.33%

According to the Table VI, it is evident that the modified systems have more success in imitating the human in extracting keywords than the system without any modifications.

**G. Performance Test: F<sub>1</sub> Score Evaluation Discussion**

The performance of the machine was evaluated using the F<sub>1</sub> Score. Initially, an English Language expert (ELE) and an author of the paper generated the controller dataset of keywords from the 14 tweets used for the Turing Test, from Section C. Two human generated keyword sets were used factoring the subjectivity of the keyword extraction process. The average of the F<sub>1</sub> Scores from the two sets of keywords was used for the evaluation.

The F<sub>1</sub> Score(F) was calculated by analysing the keywords generated for each tweet according to the formula (Derczynski, 2013) given below,

$$F_1 = 2 * \left( \frac{P * R}{P + R} \right)$$

where,

F – F<sub>1</sub> Score

P - Precision

R – Recall

The precision (P) was computed by dividing the true positives (i.e. the number words which were common to the human and the machine data set) by the false positives (i.e. the total number words which were extracted by the machine). The recall (R) was computed by dividing the true positives by the total number of words which were extracted by the human.

The F<sub>1</sub> score was computed for System A and System C. The results for dataset by the ELE is included in Table IV.

**Table IV - F<sub>1</sub> scores for English language expert’s dataset**

		System A			System C		
Tweet#	Word#	P	R	F1	P	R	F1
1	9	0.40	1.00	0.57	0.50	1.00	0.67
2	11	0.43	0.75	0.55	0.60	0.75	0.67
3	25	0.38	0.60	0.46	0.50	0.80	0.62
4	15	0.71	1.00	0.83	0.80	0.80	0.80
5	24	0.55	0.86	0.67	0.44	0.57	0.50
6	25	0.23	0.75	0.35	0.36	1.00	0.53
7	25	0.25	0.40	0.31	0.45	1.00	0.63
8	23	0.25	0.67	0.36	0.60	1.00	0.75
9	9	1.00	1.00	1.00	1.00	1.00	1.00
10	7	1.00	1.00	1.00	1.00	1.00	1.00
11	7	1.00	1.00	1.00	1.00	1.00	1.00
12	20	0.30	1.00	0.46	0.43	1.00	0.60
13	13	0.83	1.00	0.91	0.83	1.00	0.91
14	10	1.00	0.71	0.83	1.00	0.86	0.92
Average		0.59	0.84	0.66	0.68	0.91	0.76

The results show that the System C has improved from a F<sub>1</sub> score of 0.66 to 0.76.

The F<sub>1</sub> score computed for the dataset extracted by an author of the paper is included in Table V below,

**Table V - F<sub>1</sub> scores for the dataset by an author**

		System A			System C		
Tweet#	Word#	P	R	F <sub>1</sub>	P	R	F <sub>1</sub>
1	9	0.47	1.00	0.57	0.50	1.00	0.67
2	11	0.57	1.00	0.73	0.80	1.00	0.89
3	25	0.38	0.60	0.46	0.50	0.80	0.62
4	15	0.71	1.00	0.83	0.80	0.80	0.80
5	24	0.55	0.86	0.67	0.44	0.67	0.53
6	25	0.23	0.75	0.35	0.36	1.00	0.53
7	25	0.50	0.57	0.53	0.45	0.71	0.56
8	23	0.38	0.75	0.50	0.80	1.00	0.89
9	9	1.00	0.80	0.89	1.00	0.80	0.89
10	7	1.00	1.00	1.00	1.00	1.00	1.00
11	7	1.00	1.00	1.00	1.00	1.00	1.00
12	20	0.30	1.00	0.46	0.43	1.00	0.60
13	13	0.83	1.00	0.91	1.00	1.00	1.00
14	10	1.00	0.83	0.91	1.00	1.00	1.00
Average		0.63	0.87	0.70	0.72	0.91	0.78

The F<sub>1</sub> score of the modified System C has increased from 0.70 to 0.78. The average of the two F<sub>1</sub> Scores obtained from the two sets are summarized in the Table VI,

**TABLE VI - SUMMARY OF F<sub>1</sub> SCORES**

System Tested	ELE Dataset	Author Dataset	Average
<b>System A: Stanford CoreNLP with the Twitter model</b>	0.66	0.70	0.69
<b>System C: Stage 2 of the machine</b>	0.76	0.78	0.77

The highest F<sub>1</sub> scores are recorded from the Tweets which of shorter length, proving that the accuracy of the machine is high in short tweets.

## V. CONCLUSION

The traditional machine learning based NLP tools have failed to accurately classify the tokens of the tweet with POS tags.

The paper presents the Twitter Model of KeyXtract, a system developed with a mix of machine learning and a rule-based approaches. A combination of the Stanford

Core NLP and the Twitter-POS tagger model was used for POS tagging to extract keywords from the tweet. The rule based approach was used to remove unnecessary words from the initial word group selection with the help of corpora. The research was developed in two stages. Stage 2 included modifications to Stage 1 such as using NER to remove time indicators and measures to include negation markers.

The research was evaluated using two methods. The ability to imitate the human logic in extracting keywords was measured with the help of the Turing Test while the performance was measured using the F<sub>1</sub> Score.

The final modified system passed the Turing Test with an overall result of 83.33% There were more instances where the modified system produced the same set of results as humans. Since the system from stage 3 consists of the improvements made to the system from stage 2, the evaluation results look quite promising. The system could be tested with a larger population for nuance results.

The performance measures of the system showed that the F1 scores increased from 0.69 of system A (system without any modifications) to 0.77 of system C (final system with modification). It was also evident that the system's level of precision was high in analysing short tweets.

Future work in the research could include the use of a complete domain specific corpus and the ability to analyse emoji, which would improve the accuracy of the keywords extracted by keyword matching. As this approach uses linguistic features to extract keywords, the same approach could be applied to other NLP tools

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# CHATBOTS: THE NEXT GENERATION IN COMPUTER INTERFACING - A REVIEW

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**Abstract** – Computer interfacing is now moving towards more machine driven communications than the Command-line or graphical user Interfacing. Human-Computer speech through communication is now gaining momentum as a technique of computer interaction which paved the way for enormous developments using natural language processing. Such systems are precisely designed to simulate how a machine could behave as a conversational partner. A Chatbot is a computer program that stimulates intelligent human conversation using a natural language. This could be done through textual or auditory mechanisms. These Chatbots facilitates easier learning of the domain concepts and their interrelated relationships which make them efficient in the use of general applications. Chatbot architecture integrates a language model and computational algorithms to emulate informal chat communication between a human user and a computer using natural language. Recently, Chatbots techniques are widely used for various practical purposes and made available to the public. The objective of this paper is to review significant conversational agents that have been developed in Sri Lanka as well as in the other parts of the world for various domains over the past years. The development techniques, approaches and functionalities are pointed out through this paper.

**Keywords** - AIML , Chatbot , Natural Language Processing

## I. INTRODUCTION

User interfaces are referred to as the graphical, textual and auditory information that a program parses to a user. After decades of development, at present there exist several types of interfaces. The shift of computation intensive design to presentation intensive design is one of the largest steps in software development. The era of command line interfaces which occurred in late 1960s allowed users to respond using a visual prompt by typing in commands. The MS-DOS prompt application of Windows is one of the widely used. The story became interesting and wide spread with the invention of digital computers. As a result, Graphical User interfaces(GUI) emerged. GUI allows users to interact with devices through graphical icons instead of text- driven commands. Direct manipulation of graphical elements performs actions in a GUI. The next generation of innovation was taken to another level which allows users to interact using voice commands. The latest evolution of user interfaces is conversational agents. These use natural language to communicate with the user for eg Siri, cortana.

In 1950, Alan Turing distributed his well-known article “Computing Machinery and Intelligence” what is presently called the Turing test (Turing A.M, 1950) as a foundation of intelligence. This measure relies upon the capacity of a computer system to imitate a human

in a constant composed discussion with a human judge. (French, 1990) In 1966, ELIZA which was developed by Joseph Weizenbaum is recorded as the first ever program to pass the Turing test. ELIZA is considered as a clinical agent which runs on a time-sharing framework which can automatically handle several patients in an hour.

Chatbot architecture integrates language models and computational algorithms (Setiaji and Wibowo, 2016) to emulate informal chat communication between a human user and a computer using natural language. Speech based search engines and assistants such as Cortana by windows, Siri by Apple and Google Chrome are gaining a surge in the commentary context.

The development of chatbots involve extensive knowledge acquisition which is stored into the system to function with user queries. Use of Artificial Intelligence Markup Language (AIML) is widely seen in the development of chatbots. AIML supports dialogs in natural language which is then matched to an input query to given text pattern. The use of chatbots is visible in a miscellaneous set of applications both online and offline. Chatbots could be used as a tool to learn, to access information in a system, as a question and answering tool for a specific domain and in many different fields like medicine, education, entertainment, automobile or any other.

ALICE, Mitzuki which won the Leobner Prize in 2013, Cleverbot are some of key chatbots while Jabberwacky, Watson and botster some other chatbots used for different purposes. This paper reviews many exiting systems that use this chatbots techniques in their development. The presented systems are from different fields proposing to address different problem domains. The features, functionality and methodology of these systems are also presented in this paper.

This paper gives an overview of the existing chatbot systems including their approaches and functions. The rest of the paper is organized as follows. Section 2 presents about Chatbot fundamental design techniques and approaches. Section 3 reviews existing systems on chatbots. Finally, conclusion is given in section 5.

## II. CHATBOT FUNDAMENTAL DESIGN TECHNIQUES AND APPROACHES.

Building a chatbots requires many different techniques to be implemented together. Several key techniques that are

widely used in development are also looked in to within this content.

### 2.1 Artificial intelligent Markup Language (AIML)

AIML is an XML complaint language that is widely used in designing chatbots. This is mainly based on the technology used for ALICE. The goal of AIML language is to direct the process of conversational modeling in to a stimulus response process. AIML characterizes the type of data object whose responsibility is to model conversational patterns. These could be named as the frequent tags and the bases used in the design of AIML chatbots who respond intelligently. Below shows the structure of category, pattern and template object used in AIML.

```
<category>
  <pattern> User Input</pattern>
  <template>
    Corresponding Response to input
  </template>
</category>
```

### 2.2 Pattern matching

Pattern matching is the techniques of checking a given sequence of tokens for the presence of some patterns. Chatbots use this techniques as a common practice and it is frequently seen in question and answering systems. One of the key ways of developing a chatbot is by analyzing the input and finding the best match. Chatbots systems practice these patterns matching techniques mainly because to make the users feel that they are chatting with a real human. ELIZA use a matching keyword and application of transformation rules. In this process, the conditions of all topics are compared to the goal information, the query and the keyword list. As a result, the topics are scored and the highest score out of all is returned as the answer.

### 2.3 Parsing

Parsing is the process which is used in analyzing a string of symbols either in computer languages or natural languages. In computational linguistic parsing is used to analyze a sentence or another set of strings in to its constituents which may contain semantic and other information. This technique includes analyzing the input text and manipulating it by using several NLP functions. One such example is trees in Python NLTK.

**2.4 Chat scripts**

Chat scripts are often used when the AIML does not provide any matching in its context is a sequence of expect strings. Chat scripts mainly focus on the best syntax out of all the provided syntaxes given to provide a sensible answer to system. Variable concepts, logic and facts are some of the functionalities that chat scripts address.

**2.5 ontology**

Ontologies are used in chatbots to compute the concepts of synonyms, antonyms, hyponyms and other co concepts that prevail in any natural language

**III. EXISTING SYSTEMS**

Through further studies for years the researchers could develop various efficient systems with the use of chatbots techniques which is a catalytic section in the field of Natural language processing. This section describes the systems that was developed in the recent past which are applicable for various fields such as medicine, education, entertainment etc.

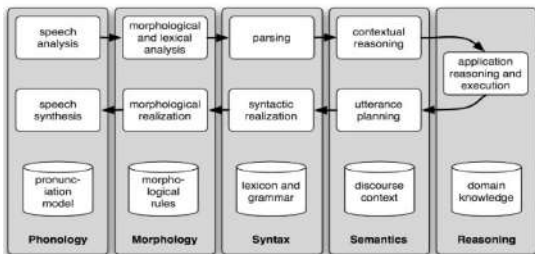
ALICE (AbuShawar and Atwell, 2015)is one of the earlier developed chatbots. Shawar and Atwell presents an overview of ALICE chatbot, its AIML format and their experiments they used to generate different prototypes of ALICE based on a corpus approach. A description of developed software which converts readable text (corpus) (Shawar and Atwell, 2005)into AIML format is presented alongside with describing the different corpora that is used in this system. A Java program that converts a readable text to the chatbot language model format is developed. The entire program has been divided in to four phases to handle the linguistic annotations and filters. The approach used is a Dialog Diversity Corpus of English along with an after-text reprocessing and filtering using the developed java program. A monologue bilingual corpus was also used in this process.

Shawar, Eric Atwell (Shawar and Atwell, n.d.)present a program developed to convert a machine-readable text (corpus) to a specific chatbot format, which is then used to retrain a chatbot and generate a chat which is closer to human language. Different corpora such as dialogue corpora, monologue corpora such as holy Qur’an (Bayan Abu Shawar and Eric Atwell, n.d.)and FAQ s have been used here. The main goal of this process is the ability to generate different chatbot prototype that spoke different languages.

A java program that converts the corpus to the chatbot language model format has been developed which aims to create ALICE knowledge base automatically and based on specific corpus or domain. To handle the linguistic annotations and fillers, the program is composed of four phases. The system could generate AIML training data for ALICE chatbot to serve in different domains. (Shawar and Atwell, 2003a)

Chatbots could be used in various fields such as education, medicine, and entertainment, business etc. Several applications that could be used in day today life has been developed by the researchers in modern days. The first Sinhala chatbot (Budditha Hettige and Karunananda, 2006)developed by Hettige and Karunananda is a useful system that has been developed to communicate in Sinhala language. This system has been developed as an application of a Sinhala parser that comes under a major component of the project in English to Sinhala machine translation system. The system has been developed using JAVA and SWI-PROLOG supporting both Linux and Windows. As the major components, this system comprises of a Sinhala Morphological analyzer and a Sinhala Language parser. (B. Hettige and Karunananda, 2006)

The Sinhala Morphological analyzer connects with three dictionaries namely, base dictionary, rule dictionary and concept dictionary. Knowledge identification engine reads all the information given from Sinhala language parsing system. It uses simple pattern matching algorithm to identify user input and find the appropriate solutions from knowledge base. This has been developed as an automatically updating system where the knowledge base is updated whenever the users use this. Further it is stated to extend the chatbot to operate on a more specific domain.



**Fig1 -Overview of ALICE chatbot**

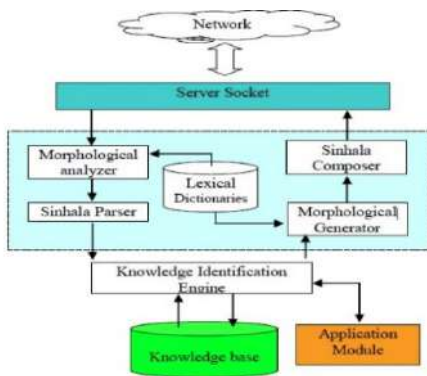


Figure 2 - Overview of the Sinhala chatbot

Abdul-Kader and Woods (Abdul-Kader and Woods, 2015) presents a survey on the techniques used in designing chatbots. As per survey most research work has focused on improving recognition rates of the human voice and the technology is now approaching viability for speech based human computer interaction. Different techniques that could be seen in these applications are compared. Features and functions of the NLTK is also described here. A responder, classifier and graph master are three main parts in a chatbot. Parsing, pattern matching, AIML (Richard S. W A L L A C E, 2003) chat script, SQL and relational database, Markova chain, language and ontologies are some of the key techniques of chatbots that are described. Review of recent chatbots which are used in different sectors along with their functions are also discussed here. The ranking of several chatbots along with their functions are presented through this.

Shawar and Atwell presents a comparison of two chatbot systems, ALICE and Elizabeth (Shawar and Atwell, 2002), (Shawar and Atwell, 2003) illustrating the dialogue knowledge representation and pattern matching techniques of each. ALICE was found to be better suited for training using dialogue corpora because of its simple patterns templates and simple matching technique. A general description about ALICE chatbot, the AIML data objects, types of categories in ALICE, pattern matching in Alice and its algorithms are described here. ALICE is a software robot or program that you can chat with using natural language. Elizabeth is an adaptation of the Eliza program, in which the various selection, substitution, and phrase storage mechanisms have been enhanced and generalized to increase both flexibility and adaptability.

It is concluded that they decided to train ALICE rather than Elizabeth to learn from human dialogue corpora for two

reasons. Firstly, the AIML format is closer to the markup format used in annotated corpora. Secondly, the simplicity in generating patterns/templates, and applying simple pattern matching technique. The conclusion relating to Corpus Linguistics is that the Dialogue Diversity Corpus (DDC) illustrates huge difference in dialogues.

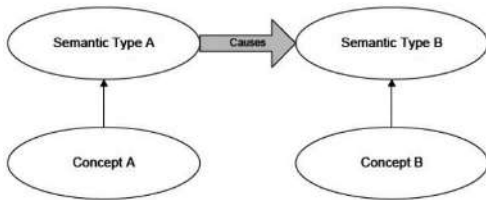
ELIZA (West et al., 1985) by Joseph Weizenbaum is a system that is implemented within the MAC time sharing. ELIZA can converse in natural language. ELIZA analyzes the user provided statement and generate the corresponding response. The input is read and analyzed with the presence of a keyword and when a specific word is matched, the other words will be deleted and the sentence will be transformed according to the associated rules.

ELIZA scripts exist in Welsh and German other than English. One major problem in this system is text manipulation. ELIZA script contains a list of structures. The actual keyword directory is created once the script is read. The performance of ELIZA is significant when the first input is given by the user.

Use of technology in the field of medicine (Vales and Sukhanya, 2009) is stepping forward rapidly. One such initiative is "Pharmabot" (Comendador et al., 2015), which is defined as a pediatric generic medicine consultant chatbot. Developed by Comendador, this Pharmabot will converse in order to prescribe, suggest and provide information on medicine for children. A left to right parsing algorithm is used in the development. Details about some chatbots such as Erica which is developed for dental practices, ELIZA which stimulates a psychotherapist and about PARRY are described in this paper.

Visual C# has been used in the development and is designed to run as a standalone system. The user will be asked several questions there by the properly answered ones will be directed to the parsing algorithm. As a significant fact of the system this provides a dictionary database which contains technical and medical terms for any novice user. The calculation which has been done through a weighted mean method depicts that this system function and generate the same results that is expected from a manual system.

Another application of chatbots in the medical field is MedChatBot (Kazi et al., 2012). This is based on AIML and Unified Medical Language System (UMLS) based. UMLS contains around two million medical concepts including variety of medical domains (Webber, 2005) and about 135 semantic types.



**Figure 3 - Relationships between Semantic Types of Concepts in MedChatBot**

This uses SQL queries and a knowledge base to return the result in natural dialog. Chatterbean, the open source java based AIML interpreter has been used in this system for its further development. There are three major components in the architecture of the MedChatBot namely the front end, the AIML parser and the database. The user inputs the question.

One of the limitations of the system is that at times the system will be unable to produce accurate responses to the queries due to lack of causal relationship between concepts of UIML. 150 queries were gathered from five random students accounting to 30 from each. Then these collected queries have been tested by expert and the system has generated results at a higher rate.

“Octopus” (B Hettige and AS Karunananda, 2015) which is a multi-agent chatbot is another application of chatbot which uses Sinhala language. This is structured with 8 sub multi agent systems namely core system, GUI system, Natural Language Processing system, communication system, learning system, action system, searching system and data access system. The development is done through the framework MasMT which is a multi-agent framework. Octopus functions through text input which also provides action searching facilities such as to execute commands, open or close applications. This has been developed as a java application running on Windows and Linux. The current version of Octopus is said to have limited capability in semantic processing. Improving such aspects and passing the turning test is stated as future work of the system.

Bradeško and Mladenčić (Bradeško and Mladenčić, 2012) compare the technologies of the chatbots that have won the Loebner Prize. The technologies and approaches of those chatbots are presented in this paper. The Loebner Prize Competition is an annual competition held for chatbots to check its capabilities, through Turing test method.

Chatbots like ALICE, CLEVERBOT, Suzette, Rosette are some of the award winning chatbots (Konferenca Jezikovne tehnologije et al., 2012) The technologies, language tricks, technical approaches and their respective algorithms are presented through this paper. Pattern matching, Markov chain models, parsing, ontologies and chat scripts of different chatbots are also explained through this paper.

Ontologies such as OpenCyc (Lenat, 1995) have been widely used in chatbots. ALICE’s main technology, AIML is most often used in many other chatbots too. Non-sequitur, simulation of keystrokes and canned response are some of the language tricks described here which are used by many intelligent chatbots.

Using chatbots in the field of education can assist people in many ways. One such application is using Bots as Language learning tools. Wang and Petrina (Wang and Petrina, 2013) in their paper presents how to predict and advise the design of a language tutor called LUCY using learning analytics. Further the paper describes student learning methods, data trails, chat log architecture which could be useful in designing more sophisticated language learning bots.

Lucy comes in two forms as a commercial chatbot and as an intelligent chatbot. Commercial chatbot Lucy is introduced as a digital language tutor to carry extensive conversation with learners as they speak. Lucy provides the users with a feedback regarding their pronunciation and provides exercises. Hosted on Pandorabots, Lucy is an online tool which guides learning in reviewing grammar and vocabulary (Jørgensen and Phillips, 2011). This chatbot Lucy provides several modules such as travel English, hotel English, restaurant English, causal talks and helping visitors. The paper describes the importance of applying learner analytics for understanding the design of the intelligent chatbots.

Even though the chatbots are designed in a specific procedure, through research it is found that the linguistic style of chatbots is altered over time (Ali et al., 2012). The study done by Ali shows that chatbots depict a certain behavioral drift in their styles. Alice, CleverBot, Hal, Jeeney, SkyNet, TalkBot, Alan, MyBot, Jabberwock, Jabberwacky, and Suzette have been used for the experiment. The data for the current study has been collected over years and contains only the chatbots that were used in their previous study about “Evaluation of authorship attribution software on a Chat bot corpus.” (Ali et al., 2011) The experiment

has been conducted through a model built for authorship identification called RapidMiner.

The confidence value of the chatbot has been taken as the key parameter. Jabberwacky had shown more positive results compared to the others. These experiments had several variations in the styles while some styles were steady. As stated the reason could be their intelligent algorithms. Performing additional research on these chatbots are focused as future work in this.

Chai(Chai et al., 2001)provides an effective solution for information access through a web based natural language dialog system. This system allows users to find relevant products on e-commerce sites. The main aim of this system is to provide a better experience for the users who are frustrated by menu driven navigation and keyword search. The dialog system is built on a traditional rule based technology.

The architecture is a support mixed initiative dialogue with multiple modalities. The natural language assistant (NLA) in this system uses a hub and spoke architecture. The authors have chosen C for the implementation of the statistical parser due to its efficiency. The system reports that the average number of clicks has been reduced by 63%. Defining quantitative and objective measures of system's success is stated as further work by the authors.

At present chatbots are developed for various domains for various languages. Poongkuzhaki(T.Kalaiyarasi et al,2003) is an intelligent chatterbot developed for Tamil language by T.Kalaiyarasi. The main function is to produce responses to given inputs for any existing topic. If the user is in a pause the system will initiate the conversation. Identifying key words in Tamil and discovering the minimal context in the question is stated as the prominent technical issues faced. The means to overcome such issues are also addressed here. The time complexity of the system is of order  $n$  where  $n$  is the input word count. Voice enabling and advanced grammar Handling is mentioned as future work of this project.

## IV. CONCLUSION

This paper reviewed a wider range of applications where chatbots can be used. After various advance studies chatbots are now used in fields like education, health

care, language learning etc. Through a proper study of the techniques and tools that prevail researches can develop efficient and useful systems to the mankind. Rule based approaches or pattern matching techniques could be used to develop a successful system. There is clearly an increasing trend matching towards to develop wide range resources and tools to be used in this field. This paper presented unified overview of some selected papers which involve techniques and approaches in their development. Using such approaches along with theories of implementing chatbots could be used to develop numerous systems to assist the world.

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# INTELLIGENT NEWS READER

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**Abstract** - News is one of the most essential requirements from the beginning of the history, it is anything that is exciting, that narrates to what's happening in the world, what's happening in areas of the nation that would be of interest to the particular audience. With the invention of media people get to know about the current situation of the country as well as the whole world through it. But because of the complex routines of life they are not able to allocate much time to listen news. Internet has transformed the boundaries of news with fast and easy access. But still people bothered about the validity of the news they heard. To become a good news it should be clear, precise and brief.

This paper reports the design and implementation of the "Intelligent News Reader" application which can be known as a great solution to the busy scheduled users concerning their thirst of news. Basically this product is based on the natural language processing, text to speech conversion, which converts the characters in words into audio format that sounds just as the words are spoken. News which is needed for the software is taken from the prominent news websites with the use of web parsers. The news taken from the websites are finally converted into a meaningful format, which can be easily captured by the users.

**Keywords** - Web Scrapping, HTML parsing, Text to Speech Conversion, Text comparison algorithm

## I. INTRODUCTION

News has become the most important source to get a knowledge regarding the day to day events happening around the globe. News travels through many different media based on printing, broadcasting, postal systems and communication. Since majority of the society are really busy with their routines activities, they cannot allocate much time for listen or observe news broadcast on television, Radio Channels or News Papers. Consequently in the present society most of the people are not aware about the current situation in the world. Because of that social media transformed the way consumers receive and participate in news. Gradually they lured people towards social media sites, gossip sites, online reading sites which people consider as unreliable sources. (Alejandro, 2010) Since most of the people deal with their laptops and handheld device all the time, and if they are able to listen for those news while engage in their day to day works it will be a wonderful experience for them. Intelligent News Reader is an automated solution for the busy scheduled users regarding the day to day events around the globe. It affords news for its users from reliable sources (like prominent news websites) by extracting news in an accurate format and speak them out to its users in a clear and precise manner. A user can separately listen to the headlines and news in detail by using this application and he or she can activate this program in any time period of



day and listen to the news while doing his or her routine activities.

There are no similar applications to this solution. Currently there are text readers built from several languages. They are capable of reading a given text to the listener. For that speech synthesizers are used. Several text readers are produced from java, python and C#. Html parsers are needed for the proposed application to grab the news from the prominent websites. DOM-based Content Extraction of HTML Documents is an early research done related to the topic. Abstraction method of text summarization, which is based on natural language generation is used to develop this application.(Michele Banko, n.d.) The Columbia Newsblaster<sup>1</sup> system has been providing summaries of topically clustered news daily and it aid daily news browsing by providing an automatic, user-friendly admittance to important news topics, along with summaries and links to the original articles for further information.

This paper reports the design and implementation of “Intelligent News Reader which is designed to the busy scheduled users. The design architecture and technology methods are also given in the paper.

The rest of the paper is organized as follows. Section 2 reports brief summary of the existing frameworks and systems. Section 3 gives on the technology behind this application. Then section 4 gives Design and implementation of the Intelligent News Reader with a brief description of each module and section 5 depicts how application works as defined. And also section 6 presents about the results of evaluation. Finally section 7 gives conclusion and further works of the project.

## II. CURRENT PRACTICES

Currently there are no similar applications to this product, but there are applications created by several researchers by using the key technologies used to develop this application. Here presents about the key findings which are already available in the field of technology and technologies which inspired to carry out this application.

### A. Text to Speech Conversion

Text to speech conversion is used to create models of the human vocal tract to generate a synthetic human voice output conforming to input text. Text-To-Speech system

processes are usually different than live human speech invention. Text-To-Speech conversion contains of two parts; namely the Natural Language Processing (NLP) unit and the Digital Signal Processing (DSP) unit. Natural Language Processing unit consider phonetization and pitch along with rhythm and it outputs a phonetic transcript of the input text. The Digital Signal Processing unit converts the phonetic transcript it obtains into machine speech. (World Congress on Engineering et al., 2014)

It should contain text analyzer which contains pre-processing block which converts numbers, abbreviations and acronyms into full text when needed. The morphological analysis block which classifies each term in the sentence presence analyzed into thinkable parts of speech, like word’s spelling. The contextual analysis module which modernizes the list of conceivable parts of speech of words in sentences and finally the syntactic-prosodic parser track down the text structure. And Phonetization model which helps to phonetic transcription of incoming text and Prosody generation concentration on specific parts of a sentence, such as emphasis laid on an exact syllable, thus attributing special position or difference to that part of the sentence.

Rhythm is a significant factor that marks the synthesized speech of a TTS system more natural and comprehensible, the prosodic configuration offers essential information for the prosody generation model to generate effects in synthesized speech. Numerous TTS systems are established based on the principle, corpus-based speech generation. It is very common for its high feature and natural speech output.

When relating to text readers, there is a German text-to-speech synthesis system Mary, which was established as a research and development tool. It contains with modular design and XML-based system-internal data illustration. However, as the MARY system uses an XML based data representation. (Schröder and Trouvain, 2003) System receives both plain text input and input marked up for speech synthesis. The input markup language, currently SABLE and the W3C draft version of SSML, is interpreted by this module into the system-internal Mary XML format, upon which successive modules will operate. The understanding indications uttered in the input markup are reflected as supplements to the modules’ text-to-speech analysis of the input. Each module enhances new or more comprehensive information. The tokeniser cuts the text into tokens, i.e. numbers, words, special characters and

punctuation marks. It uses a set of rules firm through corpus analysis to label the meaning of dots based on the nearby context.

## B. html parsers and Web Scrapping

html parsers are needed for the proposed application to grab the news from the prominent websites. DOM-based Content Extraction of HTML Documents is an early research done related to the topic. In directive to examine a web page for content extraction, the page is first passed through an HTML parser that modifies the HTML and creates a Document Object Model tree illustration of the web page.

Scrappy is intended to scrape web content from sites that are collected of many pages of comparable semantic arrangement.(Amir Ghazvinian1, n.d.) The system is employed as a Firefox browser extension, and works in three main steps to scrape web data. First, a user steers to a page that he would like to scrape and makes a model for the content that he would like from that page. Then, the user chooses a set of links that point to pages matching the content template definite by the user. First phase in obtaining data from the web by Scrappy is to make a template that can be functional to scrap data from multiple pages of comparable structure. The user steers to a page that comprises links to a set of pages corresponding the template quantified in the previous step. Here, the user can choice the links that he needs to scrape simply by click on them. When the user hovers over a link in link assortment mode, Scrappy highpoints a set of similar links. Clicking on any of these links will choice and highlight all of them for scraping, which saves the user time in agreeing links for scraping. Once the user has quantified a content template and has designated a set of links to crawl, he simply selects an output. That is the theory behind the Scrappy which is developed by the Stanford University.

## C. Text Comparison and Processing Method

Since there are same news from different news websites, it is essential to remove the duplicates. For that text comparison algorithms have been used. Those algorithms are called “String metric algorithms”. Such algorithms are used to find the word patterns with the variances like insertions, deletions or replacements.(Jokinen et al., 1988)For the purpose of learning the differences between words there are several algorithms used in the computer science field. These algorithms are used in dynamic programming for the purpose of having an optimized

result. (Pandiselvam.P and Marimuthu.T, n.d.)(Cohen et al., 2003)The algorithms can be known as Hamming distance algorithm, Levenshtein algorithm, Smith Waterman algorithm, Boyer –moore algorithm and brute force algorithm.

Concerning the advantages and disadvantages of several algorithms “Levenshtien algorithm “has been used to build this application. It calculates minimum number of character edits required to edit two words. (Cheapest way to transform one string to another.) This transformation can be an insertion, deletion or replacement of a character. This algorithm also can be known as “Edit distance algorithm”.(Van der Loo, 2014)

When concerning about the usage of this algorithm, spell checking applications, correction structures for optical character recognition, and software to support natural language translation based on translation memory, DNA analysis, and plagiarism detection can be identified. The Levenshtein distance can also be calculated between two lengthier strings, but the cost to calculate it, which is approximately proportional to the product of the two string sizes, makes this unrealistic. Therefore, when used to aid in fuzzy string searching in solicitations such as record linkage, the matched strings are commonly short to help increase speed of evaluations.

To find the similarity between the tokens “Bipartite graph” was used. For that “Assignment problem” is used.(Kuhn, 2010) Bipartite graph is a graph whose vertices can be separated into two disjoint sets and every edge links a vertex in to one in and are generally called the parts of the graph. The bipartite graph configuration can be used to seize a relationship between two types of objects where the dissimilarity between the types of objects is significant. In order to solve the assignment problem using bipartite graph, Hungarian method is used. From Hungarian method, a user can calculate the maximum weight of bipartite match.

As mentioned earlier, there are several models developed by several researchers using the technologies which used in this application. But there is no similar application like this “Intelligent News Reader”. By evaluating and considering the limitations and the advantages of those implementations “Intelligent News Reader” is developed. Below section put forward about the technologies and theoretical advancements which have been used to develop this product.

### III. TECHNOLOGY BEHIND THE APPLICATION

This section depicts about the theory and technologies lies behind this application.

#### A. Text to Speech Conversion

Text to Speech technology is the method that used to convert the normal text format into an audio format. Here the sentence which needs to be read should be properly analyzed. This analyze should cover whether there are nouns, phrases in the sentence, tense of the sentence and also the beginning and the end of the sentence.

When concerning about this “Speech Synthesis” process, there are three major steps related to it. First thing is “Text Normalization”. Here in text normalization it identifies the phrases and the parts in the sentence. The second process is “Linguistic Analysis.(Swetha and Anuradha, 2013) Here it recognizes the process or the stream of the sentence. Normally there are alterations between written and spoken forms of a language, and these variances can lead to indeterminacy or indistinctness in the pronunciation of written words. Therefore the step should be properly covered. The third step is the “Prosody Generation”. Prosody is the set of structures of speech output that comprises the pitch (melody or intonation), the rhythm, the pausing, the speaking rate, the weight on words and many other features. Producing human-like prosody is significant for creating the sound of speech more natural and for properly conveying the meaning of spoken linguistic.(Dennis H. Klatt, 1987)

Text to speech applications always read sentences as single, context-independent substances therefore it is needed to thoroughly consider about the spellings and the text formatting in the sentence. Commas are used to consider the pauses in the text and it will create a significant impact to the synthesis speech. Without commas, Text to speech sounds too fast and abnormal. There should be intervals between the each and every sentences to become more natural. Therefore it is really good to consider about the correct punctuations in the application.

#### B. Use of Web Scrapping and xml Document

Most of the Webpages are designed using text based mark-up languages like HTML and XHTML. To extract the news from the websites, reaching to its code level is essential.

According to the requirement, grabbing the headlines and the detailed news is the major functionality behind the application. Therefore separate XPath queries have been written to identify the paths to the relevant news websites. As per the requirement the application should be able to format the news into a meaningful manner and the repeating groups and unnesseray points should be removed, for this purpose the application loads the news into a separate XML document, in order to manipulate the proper outcome from the news. This xml document will be helpful to analyze the news into a proper format and gives a meaningful output to the users.

#### C. Text Comparison and Processing

The news required for this application are taken from the prominent news websites. Therefore the contents of those websites can become similar sometimes. If that kind of situation occur in this application, it will become a nuisance for the users and it will reduce the quality of the application. Hence it is essential to remove the duplicative content from the application. To remove these duplicate content several string metric algorithms have been used. (Gao et al., 2010)

As the first method “Levenshtien Algorithm” is used. Here it consider about the minimum number of character edits required to transform a one word to another.(Eric Sven Ristad, n.d.) Here using this algorithm application calculates this edit distance and greater the levenshtien distance means strings are different. Since it is essential to find the stings with smaller differences, this is the most suitable algorithm. Since the news are created using sentences, it is needed to divide the each sentence to peace of information which is technically considered as “tokens”. The characters which separates the words are recognized as delimiters (space, commas etc.) and to identify the delimiters “Regular Expressions are used.

Normally sentences can be considered as a list of tokens. Therefore to identify the similarities between those sentences “Hungarian method” was used. This method was used as reducing the assignment problem from a bipartite graph. The usage of Hungarian method is to identify the total weight of this bipartite match. From this the needed optimized output can be achieved.

Below section depicts about the design and implementation details of the “Intelligent News Reader” application.

## IV. DESIGN AND IMPLEMENTATION OF INTELLIGENT NEWS READER

This application is developed as a standalone application, and application is developed using asp.net with the C#. The application will be able to browse the web when “Go” button is pressed by the user. The application will automatically visit the prominent news websites which are pre-defined by the user. At that time the application will extract news from the visited websites and categorized them into Headlines and News-in-details into an xml document. After that the extracted news will be processed according to a proper format. Finally the application will speak-out those news to the user in clear and precise manner. The user of the application will be able to change the volume and frequency of the application according to the preference. The application will consist with user-friendly interfaces which can be easily controlled by the user.

When concerning about the process of the application, the application can be segregated into three basic functions. They are Select the appropriate news website, Extract the news from the website, Order the news in an appropriate manner, process the news and finally Read out the news to the user.

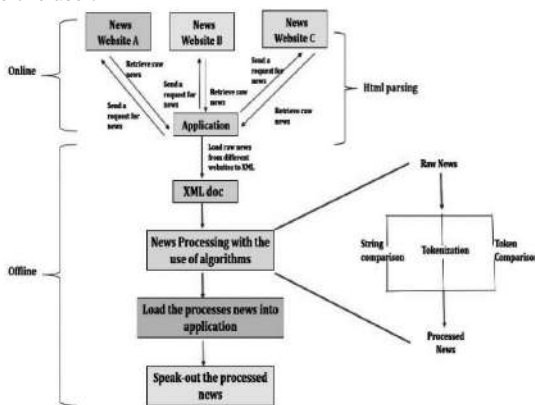


Figure 1: Process Diagram of the Application

### A. Extracting News

This is the first module of this application. Only for this module a device with internet access is required. When user starts the application and press “Go” button, application will go to the news websites. Here the application will visit to the default news websites. In addition to that user can customize the news websites as his or her preference.

### B. Text Processing and Comparison

Text analysis and summarization is the second major module in the application. This process is happening as an internal module, when user press “Go” button. As it is mentioned in the previous section, when user press “Go” button application will automatically routes to the news websites and retrieve news from it. Those news are loaded into an xml document. That xml document is used to do the text analysis process.

Since application took news from several news websites, there might be duplicative news in it, if they are available in the application, it will reduce the productivity of the application. Therefore it is essential to remove those content from the application. Therefore when the match score value is become high, it means the sentences are similar enough, it means they are duplicative. Because of that it is essential to remove a one news from it. Here the application will remove a one news content when there are same news in different news website. When the words matching count is become 50% or more than 50% this functionality works that is the process where it uses the text processing part.

Using the content generated in the xml document, it analyses the similar content and remove them. After that it keeps one news content, which is more descriptive and can be categorized as the best one. The news will automatically order according to the sequence of headline and news in details.

### C. Presenting News

This is the final output of the application and this is the output which can be seen and listen by the user. When user selects the “Play” button. Application will start speaking

## V. HOW APPLICATION WORKS

This application is developed using visual C# language as a windows form application. The only difference lies here is, it can access internet when necessary and grab the news. Since this is an application to use in a daily basis, it should have attractive graphical user interfaces. Therefore application developed with several animations and eye catching theme. It consists with three major modules and finally output is displayed as a single application.

The interfaces are developed to have a high user experience

and this is really a user friendly application. When user press “Go” button, application is going to specified news websites and retrieve the news from those news websites and load them into an xml document. The news processing part also happening in here. If user want to add more sites to the application, user can select the settings button. Using the settings button user can add or remove news websites according to the preference. And also can select whether the application needs to read the news as headlines or detailed news or both.



**Figure 2: Interface of application when user selects play button**

Button integration of this application also need to concern, all the related buttons are activated when they are necessary to activate. Other time the buttons remains disabled.

Using the button “Headlines” user can listen to the headlines only. And also using the volume controller user can adjust the volume according to the preference.

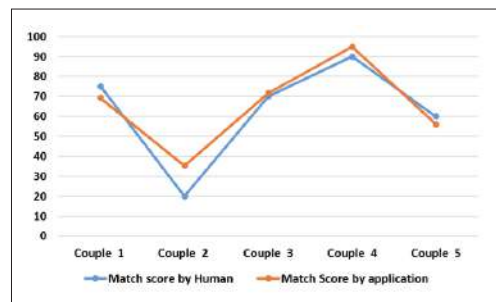
Another important thing in this application is the presenting style. It presents news in a very good pronunciation method and it is presenting style is very similar to television news presenter .Therefore the application will become a realistic experience to its user, though this is an artificially generated application.

## VI. RESULTS

The accuracy evaluation was conducted in order to find whether the match score of “Intelligent News Reader” application is similar to the match score given by the human evaluator. This criteria is really essential to remove the duplicate news coming from several news websites. Accuracy testing was conducted by the use of hundred pairs of sentences. Then the each pair of sentences were dropped to the demo application which was created for evaluation purpose and compare the similarity by giving a match score value. After that each pair of sentences were given to a human being to consider the similarity of those sentences. The results match scores of the application and human evaluator were compared and analyzed properly. The results of both evaluations are as follows.

**Table 1: Results Coming from Human Evaluator and from the Application**

Couple of sentences	Match score by Human	Match Score by application
Couple 1	71-80	69.23%
Couple 2	11-20	35.29%
Couple 3	71-80	71.6%
Couple 4	91-100	94.8%
Couple 5	61-70	56.09%



**Figure 3: Difference between Results Coming from Human Evaluator and from the Application**

Here the test results of human evaluator were appeared similarly as given by the application. Therefore the selected criteria for removing the duplicates (lesser than fifty) was recognized as a correct value.

## VII. CONCLUSION AND FURTHER WORKS

This paper has reported the design and implementation of the “Intelligent News Reader”. Further it has provided the evaluation results of the application. By analyzing the results, it is clear that Intelligent News Reader application completely meets its expected goals. As the future enhancement this application will be developed for Sinhala language.

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# WEB-BASED EXPERT SYSTEM FOR PERSONALIZED PSYCHOTHERAPEUTIC COUNSELLING

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**Abstract** - Sri Lanka has one of the highest suicidal rates in the world. It has been found that these cases were caused mostly as a result of mental health disorders, such as depression and anxiety. A recent study conducted at the Rajarata University showed that approximately 5-10% of the Sri Lankan population suffer from some form of mental health condition that require treatment. (Jaufer, 2016) This study aims to examine the development of a Web-Based Expert System which will provide Personalized Psychotherapeutic Counselling for anyone in any location. If everyone who has a suffering problem and have no one to share their grievances could use the proposed system, then everyone will have a hope and happiness in their lives and the suicidal rate would decrease significantly. The main objective of developing this system is to address all the drawbacks of the currently available face to face counselling system, while this system mainly focuses the Sri Lankan community. This system will perform as a platform to connect clients who need mental health advices, with licensed counsellors of Sri Lanka. The significance of the proposed web based counselling system is, that it will present a set of standard and psychologically approved questions to the clients before receiving the counselling service. By using Prolog Logical Programming Language, the answers provided by the client will be analyzed, and then the system will predict the area of the problem of that particular client. Then, the system will direct the client to the relevant counsellor that has specialized on that relevant

area. Finally, the client could use a preferred method of communication facilitated by the system, to communicate with the counsellor. The system will also use encryption methods to ensure confidentiality of the conversations carried out between clients and counsellors. The proposed system will be a fully integrated version comprised of a Web Application, Android Mobile Application, Short Message Sending (SMS) gateway and a Payment gateway.

**Keywords** - Personalized Online Counselling, Web Based Application, Psychological Analysis, Prolog

## I. INTRODUCTION

According to the statistics by the National Institute of Mental Health (NIMH), only 20% of mental health sufferers receive treatment, one of the main reasons being that treatment is usually available only in cities. In addition, the main problem is that Sri Lankan society neglect mental health-care or counselling due to social stigma. (Jaufer, 2016)

According to Prof. Nalaka Mendis, Professor of Psychiatry Faculty of Medicine, Colombo and Vice President Sahanaya, National Council of Mental Health, there has been a definite growth in the number of those who suffer from mental illnesses during the last ten years. Resident

Representative of World Health Organisation (WHO), Dr. Kan Tun has stated that 10% of the global problem of diseases are due to mental illness. Further he has stated that mental illnesses are commonly investigated in developing countries and especially in those countries where there was a civil war. Dr. Neil Fernando, Consultant Psychiatrist has stated that forces personnel have become mentally ill solely due to the war. According to Prof. Mendis although Sri Lanka has cheap and cost effective counselling services, the country lacks experienced doctors in the field and also the professionals in this field are mainly available in urban areas so the clients tend to neglect their need for counselling service and remain suffering and worrying. Ultimately they choose suicide as a remedy to get rid-off their untold problems. ("Mental illness on the increase -Sahanya-Island," 2001)

Most of the people keep away from face to face counselling services due to many concerns. A major reason is due to lack of knowledge. Many individuals especially in rural areas lacking education has no any idea about psychology, so even if they actually suffer from a mental illness they identify it as a Mysterious force and go for mythological remedies. Some other problems why people neglect counselling is due to financial inabilities and lack of transportation facilities. Some individuals with mobility difficulties or physical inabilities such as paralysis or problems in limbs will not be able to meet a counsellor. So they tend to remain silent and suffer alone. Reluctance to be exposed to the society is another main reason why people disregard counselling. Negligence of counselling or psychotherapy due to public humiliation is a common and a major reason in our country. Sri Lankan society consider, getting psychological advices or meeting a counsellor as a shame and label such a person as a "retard". If clients who use to attend to continuous counselling sessions, will have to migrate to another country, the client will no longer be able to meet the counsellor. Boundary barriers is another reason why clients terminate counselling.

According to my perception and study, "Online Counselling" would be the best solution to address these problems stated above. It is conventionally assumed that the first professional fee-based online individual psychotherapy started in 1995. (Metanoia,1972)

Online Counselling is a field that shows a tremendous growth in the past ten years with the advancements in technology and widespread use of the internet. Studies have identified that more clients are seeking help from online

counselling services. (Murphy et al., 2009). Currently, an Online Counselling System which focusses mainly the Sri Lankans, is not available. The proposed web based psychotherapeutic counselling system (YourCounsellor) will be designed essentially focusing the Sri Lankan community. But also the system enables any personal in any part of the world to interact with the system and to get counselling service. Online Counselling will never replace the traditional method of face-to-face therapy. Researches that have been conducted to find whether the clients choose Online Counselling over face to face counselling have identified that both the methods are accepted equally by the society. E-therapy is another way of reaching people who are unable to get any other help. (Murphy et al., 2011), (Cook and Doyle, 2002)

## II. LITERATURE REVIEW

A Google search on "Online Counseling" retrieved about 4,060,000 results, (latest result - 59,100,000 ) the top most included famous websites which provide online chat facility to acquire counseling services.(Dowling and Rickwood, 2013)

Some of the most popular websites available in present day which provide online counselling services are:

- 7 Cups of Tea
- Betterhelp
- Breakthrough System
- Butterfly
- kidsHelpline
- MindSpot
- Online Counselling directory
- PlusGuidance
- Talkspace
- YourDOST

### A. Technology

All of these web based systems uses web technology. But some of the sites such as breakthrough, betterhelp and talkspace provide mobile application facilities too. The proposed system will use both web and mobile



technologies to increase the efficiency and usability. (BetterHelp, 2013), (© Breakthrough and Policy, 2009), (Talkspace, 2014), (Baumel and Schueller, 2016).

### **B. Bi-Lingual Interface Navigation**

The proposed system will provide Bi-Lingual Page Content facility which means that the system enables the clients and counsellors to interact with the system in a preferred language, either English or Sinhala. So that even a person who has less knowledge in English could navigate via pages and use this system effectively to get counselling advices. None of the above mentioned websites provide bi lingual or multi lingual facility. So it proves that the proposed system carries a distinct feature than the other available Online Counselling sites.

### **C. Professional Counsellors**

The proposed system only allows Qualified, Licensed Professional Counsellors to be registered into the system since the system tackles with the human brain and mind, it is risky to allow clients to get help from therapists who are not qualified. Among the above mentioned systems MindSpot, betterhelp, breakthrough, talkspace, PlusGuidance provide professional advice. Other systems recruit any type of listener and allow them to advice the clients. ("MindSpot Clinic | Home.") o. The proposed system will use both web and mobile technologies to increase the efficiency and usability. (BetterHelp, 2013), (© Breakthrough and Policy, 2009), (Talkspace, 2014), (Baumel and Schueller, 2016).

### **D. Bi-Lingual Interface Navigation**

The proposed system will provide Bi-Lingual Page Content facility which means that the system enables the clients and counsellors to interact with the system in a preferred language, either English or Sinhala. So that even a person who has less knowledge in English could navigate via pages and use this system effectively to get counselling advices. None of the above mentioned websites provide bi lingual or multi lingual facility. So it proves that the proposed system carries a distinct feature than the other available Online Counselling sites.

### **E. Personalized Counselling**

The proposed system will provide therapy only by analyzing the client's mental level. The system will ask a set of questions from the client so that the client's mental level will be measured and the basic problematic area of the client could be identified. The client will be provided with the most appropriate counsellor who has specialized in that relevant area of psychological issue. Systems such as betterhelp and PlusGuidance also have the feature to measure the mental level but the proposed system is unique, that it only enables the clients to receive counselling after the mental level analysis. This method enables the client to get advices only from the relevant counsellor.

### **F. Payment Method**

Almost every other system provides therapeutic sessions after a payment. Butterfly website will not allow to access into any option without paying and signingup. Only a few like PlusGuidance and 7 Cups provide a free session for a limited time. Only the proposed system will permit a 3 Day Free Counselling Session Period which will allow the clients to check whether the counselling session worth enough. ("7 Cups Subcommunities."), ("Chat Online » The Butterfly Foundation.")

### **G. Group Counselling**

Free Group Therapy Platforms are only available in 7 Cups among the mentioned websites. Some of them provide group therapy session but for a fee. The significance of this proposed system is that all group session will be freely available for any user.

### **H. Information Security**

Information Privacy or confidentiality is a major feature that should be considered in online counselling. The proposed system will be developed, following various security mechanisms such as encryption, VoIP, IM protocols and authentication mechanisms.

### **I. Other Features**

Most of the above mentioned have complicated interfaces and also some of the pages in websites such as kidsHelpline has expired. Users might not be able to interact properly and easily since the interfaces are full of bulky information all over the page. The proposed system will have user friendly interfaces with clear navigations and guidelines

to use the system and get the ultimate services from the system. (“Teen Online Counselling | Kids Helpline | 1800 55 1800.”)

All the users should be able to access an online counselling system regardless the physical disabilities. In the proposed system a feature will be included where the mouse could be completely controlled without hand movements but eyes or head. So that all the users will have the ability to interact with the system. None of the above mentioned systems have a feature as explained.

If a counsellor which the system chooses as a match to be communicated with the client is not online, the System will notify the counsellor via an SMS notification to that particular counsellor. None of the above mentioned web based systems imposes this feature as well. Which proves that the proposed system is unique than the currently available Online Counselling System.

### III. RESEARCH METHODOLOGY

Since the proposed system will be finally used by the general society and the counsellors, the opinion of counsellors and the society should be take into consideration. So as to gather information on their views, both qualitative and quantitative methodologies will be used as data gathering techniques to design the requirement specification. Questionnaires and Interviews will be the main data gathering methods that will be used to gather the requirements and the information. All the required data will be collected by distributing a well detailed questionnaire among the general public via both online and offline methods, to grasp the opinion on introducing the proposed system which will help to identify what they prefer from such a system and also to get a statistical clarification to identify the percentage of people who use mobile phones or computer along with Internet, to ensure whether the system could be used by common people without any difficulty and barrier. Interviews will be conducted with counsellors and psychiatrists to ensure whether the proposed system will be efficient, helpful and ethical enough to serve the common people.

### IV. CONCEPTUAL MODEL

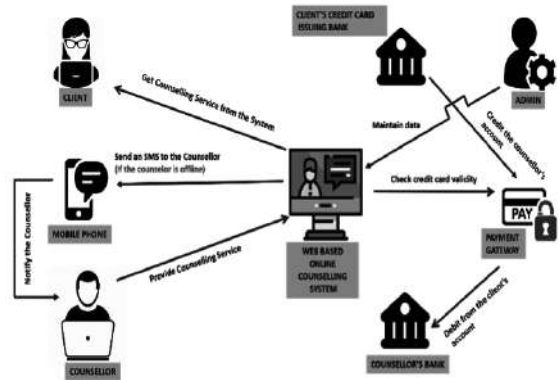


Figure 1. Overall Conceptual Model

### V. APPROACH

The main users of this system are the clients and counsellors. In addition, a system administrator can also access the system. According to the above illustrated figure 1, there are five main modules of this system. Namely they are; Admin Module, Client Module, Counsellor Module, System Module and Group Counselling Module.

#### A. Admin Module

Admin do not perform a major role in the proposed system. Admin will have access to view counsellor details, view the number of clients registered, view feedbacks and view counsellor names who have been reported by other counsellors and also the upgrades and maintenance will be performed.

#### B. Client Module

Clients will have to select the language (English or Sinhala) before any process. And also, clients with any physical impairment can enable the accessible mode on the start-up page and control the mouse using eye or head movements throughout the system. Then, the system will provide a client who is willing to obtain the counselling service for the first time, a set of psychologically approved questions before the first session. So that the answers will be analysed by the system and will predict the mental level or the problematic area of the particular client.

Then, the system will direct the client to the most specific counsellor who has specialized on that relevant problematic area. The clients can access the system and

obtain counselling service for free only for 3 days and then, after 3 days the clients should get registered to the system by creating a preferred username and a password. Clients will be facilitated with latest methods of communication such as instant messaging, voice messaging, video conferencing and many other media sharing means, to communicate with the relevant counsellors.

Clients can give feedbacks and also will have to rate the counsellors after every session. Clients will not be able to view all the counsellors in the system. The client can only view all the details such as the full name, qualifications, licence number of the counsellor who will be selected by the system which is suitable to that relevant client. Clients can also request another counsellor if he/she is not satisfied with the provided counsellor. But this request can be performed only within the free trial period. The client could terminate at any time he/she prefers.

### C. Counsellor Module

Counsellors will also be provided with Language selection and accessible mode in the start-up page. Counsellors will have to get registered to the system at the beginning. The system will approve the registration by analysing the details provided by the counsellor. Specifically, the license number provided by a counsellor will be checked from a dataset which contains licence numbers of legitimate counsellors approved by the Sri Lankan government or Internationally. The registration approval will be given to the particular counsellor, only if the license number is available in that dataset.

After registration the counsellor can login to the system and carry on with the sessions. Counsellors can also give feedbacks to the system. Counsellors can view all the details of other counsellors registered in the system, so that if a counsellor identifies an illegitimate counsellor by any chance, he/she can report that particular counsellor.

### D. System Module

As this is an expert system, the system itself performs huge complex tasks. The system will analyse the answers given by the clients to the set of standard questions and predict the accurate problematic area or the mental level and direct the client to the specific counsellor. And also before allowing the counsellors to join the system, the system will check for the validity of the provided license number. If any counsellor is offline the system will send an SMS

notification to that particular counsellor's mobile phone. Another function is that, if a counsellor be reported by 5 other counsellors the system will remove that particular counsellor who has been reported.

### E. Group Counselling Module

Group Counselling facility will also be provided by the proposed system. This will be an open space that allows any person regardless whether it is a client or a counsellor, to post their problems anonymously. Then the other members could give their opinions.

### F. Technology adopted

The most appropriate technology for developing the system have been decided by considering the system domain and the requirements. It is much significant to select the technological methodologies which will be capable to satisfy both the functional and non-functional requirements of the system. Since the proposed Personalized Online Counselling Expert System is a web based system, more consideration will be given in selecting latest technologies. The technological methodologies will be selected in such a manner that it will help the system to be available at anytime, anywhere and also to make it efficient and effective.

With an in-depth analysis of the system requirements, PHP will be used as the main programming language to develop the backend of the system. Polog is the substantial programming language that will be used to develop the complex analysis and prediction functions of the system. The knowledge base will be created by a deep medical analysis to identify symptoms of each area of medical disorder and the relevant counsellor type. The gathered facts will be logically categorized and programmed for the prediction purpose using Prolog and will be connected to the Web Application. The database of the system will be implemented using MySQL. The front end of the system will be developed using the programming languages HTML and CSS and also the bootstrap framework will be used to make flexible and user friendly interfaces. The validations of the forms and access controlling will be done using JavaScript. The system will guide the users to create a highly secured password to confirm privacy and data security. The security of online transaction details will be ensured by using data encryption mechanisms and technologies such as SSL to prevent eavesdropping and Man-In-The-Middle attacks.

CameraMouse Software will be embedded with the Web Application which enables the user to move the mouse with only eye or head movements. CameraMouse is a simple software with a simple user interface where the user must allow the camera to capture the real time face image by which it allows the user to select a point on the head, specifically eyes, and there onwards the mouse will follow that particular point. The user could navigate the selected point to left or right to move the cursor left or right respectively.

## VI. EVALUATION

An evaluation will be performed to verify whether the requirements and the objectives have been fulfilled by the system. The proposed system will be evaluated by employing three test cases. The first test case will be done by requesting a set of selected counsellors to interact with the system, check the knowledge base used for measuring the basic mental level or the problematic situation of clients, the process of directing the clients to relevant counsellors is medically approved and finally to get the approval to implement the system. The second test case will be done after receiving the approval from the professional and reputed counsellors. Then, a selected group of common people with various cultures, and people with different incapability and people from different areas of Sri Lanka will be expected to interact with the system and will be checked whether the interfaces are user friendly and understandable for everyone. Finally, after the approval of the above stated test cases, the third test case will be carried out. Here, both the clients and counsellors will be allowed to use the system to communicate with each other “online” and as well as “in-person” to crosscheck whether the predictions performed by the system is accurate and also the ethical issues will be discussed so that steps could be taken to reduce such ethically problematic circumstances.

## VII. CONCLUSION AND FUTURE WORK

The Proposed System covers the entire online counselling process with more enhancements than the existing online counselling systems, such as the opportunity to receive personalized counselling advices from the most suitable counsellor and the possibility to use various methods of communication by the clients and the counsellors. The service provided by the proposed system will be beneficial

for both ordinary and handicapped individuals, since the system has an accessible mode which allows the clients, particularly who have less capacity to handle a mouse by their own, to control the mouse pointer by their eye or head movements. As well as that, any person of any part of the world will have the opportunity to access this system. Since this system only get the service of legitimate counsellors, the advices provided to the clients will be consistent. This system will also increase the quality of life of people. From 1995, Online Counselling has provided an important service for people, to face their life dilemmas positively. Since then, various enhancements have been done to improve the effectivity and the interactivity of the Online Counselling process. The proposed system will use latest technologies to develop the system. Future enhancements can be performed, such as, enabling Navigation in Tamil Language and also language translation in real time instant messaging, so that counsellors that communicate in a particular language could easily communicate with a client that uses any language without any barrier.

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# A COMPARISON OF CLASSICAL STATISTICAL & MACHINE LEARNING TECHNIQUES IN BINARY CLASSIFICATION

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**Abstract** - Predicting a precise response for previously unseen input variables is a vital and challenging task, as precise predictions can minimize the risks related to different domains by making correct decisions. The main objective of this study was to compare the performance of several classical statistical and machine learning techniques by considering the prediction task as a binary classification. The classification techniques; Logistic Regression (LR) and Linear Discriminant Analysis (LDA) were considered under classical statistical techniques while Random Forest (RF), Naïve Bayes (NB), Boosting (BT) and Bagging (BA) were considered under machine learning techniques. The performance of those techniques were compared under the two different aspects by using five real datasets. In one aspect, class imbalance was artificially introduced to the datasets by resampling. In the other aspect sampling approaches such as undersampling, oversampling and hybrid approach (mix of both undersampling and oversampling) were considered, to overcome class imbalance in the training set. Several evaluation methods such as accuracy, precision, F-measure, G-mean and Receiver Operating Characteristics Area Under Curve (ROC AUC) were considered to evaluate the performance of the classification techniques. The results indicated that the performance of Random Forest and boosting are better than the performance of other techniques in both resampling and overcoming class imbalance aspects. In many cases when the training set was balanced, not only

the machine learning techniques but also the statistical techniques had better performance.

**Keywords** - Statistics, Machine Learning, Classification, Resampling, Class Imbalance

## I. INTRODUCTION

Predicting a response for future input variables (prediction) is one of the intentions in analyzing data. In order to approach this intention, the classical statistical techniques as well as the machine learning techniques can be used. When considering the areas such as health, education, finance, etc., predictions play a major role in decision making. Precise predictions can avoid uncertainties in decision making and then the risks can be minimized. Therefore, the most vital and challenging task is to predict responses correctly as much as possible for input variables which have never seen before with the aid of existing data. Obviously, this task highly depends on the technique (either classical statistical or machine learning) which is used for prediction. So, this study concerns in comparing several classical statistical and machine learning techniques by considering binary classification as the prediction task. Simply, binary classification is the task in allocating the observations of a given dataset into two categories according to a particular classification rule. The

classification techniques Logistic Regression and Linear Discriminant Analysis are considered under classical statistical techniques while Random Forest, Naïve Bayes, Bagging and Boosting are considered under machine learning techniques in this study (Hastie et al., 2008).

In general, both classical statistical and machine learning techniques have the same concern, which is basically learning from data, but in a different manner, where classical statistical techniques check for assumptions while machine learning techniques are used as black boxes (Breiman, 2001). According to the literature, the amount of data involved and the contribution from humans to build models differ for these two techniques.

When considering a particular scenario, different classification techniques have different performance in classifying the response. Sometimes classical statistical techniques might classify the response precisely by providing a high predictive accuracy than the machine learning techniques or in converse manner. In some other cases, both techniques might provide the same predictive accuracy. Therefore it is worth to identify when to use what.

The main objective of this study is to compare the performance of several classification methods (classical statistical and machine learning techniques) by considering following aspects.

- Data resampling aspect
- Overcoming class imbalance aspect

The other objective is to identify whether there is an effect from the above mentioned two aspects for the performance of classification methods.

## II. METHODOLOGY & EXPERIMENTAL DESIGN

### A. Experimental Aspects

This study concerned on the two experimental aspects which were depended in resampling and overcoming class imbalance phenomena. The software R was used for this study. The theories of used methods can be explained as below.

- 1) **Resampling:** The method in drawing repeated samples from the original data called as resampling. In resampling, the randomized cases are selected with replacement from original data in such a way that the each sample size is equal to the number of observations in original dataset. Due to replacement of observations, the drawn samples by using resampling methods consist of repetitive cases.
- 2) **Overcoming Class Imbalance Phenomena:** The class imbalance phenomena can be defined as, “A dataset is imbalanced if the classification categories are not approximately equally represented” (Chawla, 2005, p. 853). In an imbalance dataset, the class having a low number of occurrences is named as the minority class while the class having comparatively more number of occurrences is named as the majority class.

According to Brownlee (2015), the problem with the imbalance phenomena is that most of the machine learning algorithms may favor majority class instances. That means there is a high chance in classifying minority class instances as majority class instances (misclassifying the minority class instances). Hence achieve a high accuracy. Among the approaches available to deal with class imbalance, the sampling methods such as undersampling, oversampling and hybrid (mix of both undersampling and oversampling) approaches were considered in this study.

- **Undersampling** - This approach works with the majority class. In order to balance the distribution of classes in a dataset, this method removes a number of observations randomly from the majority class. Discarding valuable information is the major drawback of this method.
- **Oversampling** - This method works with the minority class. In order to balance the distribution of classes in a dataset, this method replicates the observations randomly from minority class. Over fitting to data is the major drawback of this method.
- **Hybrid Approach** - This method is the combination of undersampling and oversampling approaches.

### B. Cross Validation Technique

Cross validation is a model evaluation method in determining how the outcome of the considered model will generalize to a new dataset. The basic idea of cross validation is to separate the dataset into two non-overlapping sets where one is used for training the model



and the other set is used for testing the performance of learned model. The hold-out and the k-fold cross validation methods are the two well-known cross validation techniques (Schneider, 1997). According to the literature, many comparative studies were carried out by using the hold out method. Therefore by considering that aspect as well as the advantages, the k-fold (k=10) cross validation technique was used in this study.

- 1) k-fold Cross Validation Technique: In this method, the dataset is randomly divided into k mutually exclusive, approximately equal size of subsets (folds). One fold is reserved for testing while all the other (k-1) folds (all together) are used for training. Then this process is repeated for k times, by using each fold exactly once as the testing set. Finally, the average of the evaluation measures obtained from each time is used to assess the performance of model. The mostly used value for k is 10. Since there is a guarantee of using each and every data point to train the model, the accurate performance information can be obtained. Also the variance of resulting measures is reduced when the k is increased. The high computational time due to repetition process can be considered as a disadvantage of this method.

**C. Evaluation Measures**

Since this study was a comparison between classical statistical and machine learning techniques in binary classification task, the best technique was determined by comparing the performance between the techniques. The performance of evolved models and methods was evaluated by using certain evaluation criterions such as the accuracy and the predictability of the predicted model. Since the class imbalance phenomena was existed in some of the datasets used for this study, not only the individual evaluation measures but also the combined and the graphical evaluation measures are considered.

- 1) Individual Evaluation Measures: Precision, accuracy, sensitivity and specificity are the individual evaluation measures which can be obtained from the confusion matrix (Kohavi & Provost, 1998). A two-by-two contingency table which is called as confusion matrix can be shown as in Table 1.

**Table 1. Confusion Matrix**

		Predicted Class	
		Positive (P)	Negative (N)
True Class	Positive (P)	True Positive (TP)	False Negative (FN)
	Negative (N)	False Positive (FP)	True Negative (TN)

$$Accuracy = \frac{TP+TN}{TP+FN+FP+TN} \quad (1)$$

$$Precision = \frac{TP}{TP+FP} \quad (2)$$

$$Specificity = \frac{TN}{FP+TN} \quad (3)$$

$$Sensitivity = \frac{TP}{TP+FN} \quad (4)$$

- 2) Combined Evaluation Measures: The F-measure and the G-mean are the combined evaluation measures, considered in this study.

$$F - measure = 2 \times \frac{(Precision \times Sensitivity)}{(Precision + Sensitivity)} \quad (5)$$

$$G - mean = \sqrt{(Sensitivity \times Specificity)} \quad (6)$$

- 3) Graphical Evaluation Measures: In this study, the evaluation measure, Area Under Curve (AUC) in Receiver Operating Characteristics (ROC) graph was considered. A ROC graph is a technique for visualizing, organizing and selecting classifiers based on their performance. Each point on the ROC plot represents a sensitivity – false positive rate (1 - specificity) pair corresponding to a decision threshold. A test with perfect discrimination (no overlap in the two classes) has a ROC plot that passes through the upper left corner (100% sensitivity and 100% specificity). Therefore, the overall accuracy of a particular test is higher when the ROC plot is closer to upper left corner. In most of the cases, ROC AUC values lie between the 0.5 and 1 where 0.5 represents a worthless test and 1 represents a perfect test.

**D. Datasets**

The five different datasets retrieved from well-known database called UCI Machine Learning Repository were used for this study. They contain real and generated data with respect to different domains. The characteristics of a dataset such as number of observations, number of variables and types of variables (continuous, categorical and mix of both) are varied for considered datasets. Since the prediction task is binary classification, the response variables in all five datasets contain only two categories. The relevant links of the datasets are provided in following Table 2.

**Table 2. Downloaded links of the datasets**

Dataset	Downloaded Link
Gamma Telescope	< <a href="https://archive.ics.uci.edu/ml/datasets/MAGIC+Gamma+Telescope">https://archive.ics.uci.edu/ml/datasets/MAGIC+Gamma+Telescope</a> >
Wilt	< <a href="https://archive.ics.uci.edu/ml/datasets/Wilt">https://archive.ics.uci.edu/ml/datasets/Wilt</a> >
Bank Marketing	< <a href="https://archive.ics.uci.edu/ml/datasets/Bank+Marketing">https://archive.ics.uci.edu/ml/datasets/Bank+Marketing</a> >
German Credit	< <a href="https://archive.ics.uci.edu/ml/datasets/Statlog+(German+Credit+Data)">https://archive.ics.uci.edu/ml/datasets/Statlog+(German+Credit+Data)</a> >
Tic-Tac-Toe	< <a href="https://archive.ics.uci.edu/ml/datasets/Tic-Tac-Toe+Endgame">https://archive.ics.uci.edu/ml/datasets/Tic-Tac-Toe+Endgame</a> >

**E. Evaluation Procedures**

1) Procedure in Resampling Aspect: In this aspect classification techniques were compared while introducing the class imbalance phenomena artificially to the dataset. Initially, the dataset was separated into two groups by considering the two classes in the response variable. Then the observations were selected randomly with replacement from the two groups to create a new dataset which the size of it was equal to the numbers of observations in the original dataset. When considering the response variable in a dataset with two classes, one of them could be considered as ‘success’ (positive) class and the other one as ‘failure’ (negative) class according to the problem domain. The number of observations that should select randomly from each group was decided as below.

$$p_i = \frac{n_s}{N} \tag{7}$$

$$n_f = N - n_s \tag{8}$$

$p_i$  : probability of success  
 $N$  : total number of observation in original dataset  
 $n_s$  : number of observations select from ‘success’ group  
 $n_f$  : number of observations select from ‘failure’ group

Equation 7 was used to determine the number of observations that should be chosen from ‘success’ group while the equation 8 was used to decide the number of observations that should be taken from ‘failure’ group. Then a new dataset was formed by combining the randomly chosen two sets of observations which contained the same number of variables and same number of observations as in original dataset. Since the class distribution was not random in newly created dataset, random class distribution was introduced by shuffling the data row wise. When shuffling the data, the order of observations (entire row) was changed but the values relevant to an observation (values within a row) were not affected.

Then the 10-fold cross validation method was used. The above mentioned classification techniques were trained by using training set and the class outcomes were predicted by using testing set separately for each technique. When repetition was done for 10 times, each time all the classification techniques were trained by using same training set and tested on same testing set. Then by comparing actual class outcomes and predicted class outcomes, the evaluation measures were obtained for each classification technique separately. Finally, the best classification algorithm was determined by analyzing the achieved results for evaluation measures.

This whole process was repeated for 9 times by varying the probability of success ( $\pi$ ) from 0.1 to 0.9.

2) Procedure in Overcoming Class Imbalance Aspect: In this aspect, the classification techniques were compared under different sampling approaches to overcome the class imbalance phenomena. The main focus was to balance the training set. Since, the class distribution was not random in most of the original datasets, the randomness of class distribution was introduced by shuffling the dataset row wise. As in previous aspect, in here also the order of

observations (entire row) was changed while the values relevant to an observation (values within a row) remain unchanged.

Then as same as in previous aspect, the 10-fold cross validation method was applied. The approaches undersampling, oversampling and hybrid (mix of undersampling and oversampling) were applied to balance the training set derived from shuffled dataset. The same modified dataset was used under each technique separately. Finally the best classification technique was determined according to three sampling approaches. The only difference in here was that the use of balanced training set for the training process of classification techniques.

### F. Special Considerations

All the classification techniques were tested by considering the five original datasets separately. LDA is one of the statistical classification technique used in this study. The theory of LDA suggests that it is suitable when the predictor variables are in interval scale. Therefore LDA was applied only for the datasets which contained continuous variables except the response variable (Wilt and Gamma Telescope datasets). Since bagging and boosting are ensemble based methods (not stand alone methods), the classification tree was used as the single classifier. When considering on machine learning techniques, some of them use several parameters. The default values suggested by the functions in R is used for those techniques. Also feature selection and parameter tuning are important when training a machine learning algorithm. Even in logistic regression, after fitting the model the best model can be selected using stepwise methods. These scenarios were ignored in order to treat both equally for classical statistical and machine learning techniques. That means when training the considered techniques, all the predictor variables were used as well as no parameter tuning was done to the machine learning techniques.

## III. RESULTS

### A. Resampling Aspect

The results obtained for resampling aspect are summarized in Table 3.

**Table 3. Classification techniques which have highest and lowest performance in Resampling Aspect**

Precision		
Dataset	Highest	Lowest
Gamma Tel.	RF	LR
Wilt	RF & Boosting	NB, LDA (0.1)
Bank Mark.	RF	NB, Bagging (0.1) LR (0.2)
German Cr.	Boosting & RF (0.1,0.2,0.3) ↑	LR
Tic-Tac-Toe	Boosting LR ↑ (0.1)	NB
Accuracy		
Dataset	Highest	Lowest
Gamma Tel.	RF	LR
Wilt	RF & Boosting	NB
Bank Mark.	RF	NB
German Cr.	Boosting & RF ↓ (0.1, 0.2)	LR
Tic-Tac-Toe	Boosting LR ↑ (0.1)	NB
F-measure		
Dataset	Highest	Lowest
Gamma Tel.	RF	LR
Wilt	RF & Boosting	NB
Bank Mark.	RF	NB
German Cr.	Boosting & RF ↓ (0.1, 0.2, 0.3)	LR
Tic-Tac-Toe	Boosting, LR ↑ (0.9)	NB
G-mean		
Dataset	Highest	Lowest
Gamma Tel.	RF	LR, LDA (0.1)
Wilt	RF & Boosting	NB, LDA (0.1)
Bank Mark.	RF	NB, Bagging (0.1),LR (0.2)
German Cr.	Boosting & RF (0.1, 0.2, 0.3, 0.6, 0.7, 0.8, 0.9) ↓	LR
Tic-Tac-Toe	Boosting LR ↑ (0.1, 0.9)	NB
ROC AUC		
Dataset	Highest	Lowest
Gamma Tel.	RF	LR
Wilt	RF & Boosting	NB, LDA (0.1)
Bank Mark.	RF	NB, Bagging (0.1), LR (0.2)
German Cr.	Boosting & RF (0.1, 0.2, 0.3, 0.6, 0.7, 0.8, 0.9) ↓	LR
Tic-Tac-Toe	Boosting LR ↑ (0.1, 0.9)	NB

Up arrow (↑) - represents higher values  
Down arrow (↓) - represents lower values

In Gamma Telescope and Bank Marketing datasets, the technique RF has the highest performance for all probabilities of success. The techniques, RF and boosting have almost the same highest performance for all success probabilities in Wilt dataset. In German Credit

dataset, both RF and boosting have almost the same highest performance for all success probabilities except the probabilities mentioned in brackets and for those probabilities RF deviates from boosting as shown by up-arrow and down-arrow. In Tic-Tac-Toe dataset, LR has the highest performance for the probabilities mentioned in brackets and for all the other probabilities boosting has the highest performance.

According to the lowest measures, the techniques which are in italic form has the lowest measures at relevant probabilities mentioned in brackets and for all the other probabilities, mainly mentioned technique (which are in non-italic form) has the lowest measures in each dataset.

**B. Overcoming Class Imbalance Aspect**

The results obtained for overcoming class imbalance aspect are summarized in Table 4.

**Table 4. Classification techniques which have highest & lowest performance in Overcoming Class Imbalance Aspect**

Precision									
Dataset	Highest				Lowest				
	R	U	O	H	R	U	O	H	
Gamma Tel.	RF	RF	BT	RF	LR				
Wilt	BT	LDA	LDA	LDA	LDA	NB	NB	NB	NB
Bank Mark.	NB	RF	BT	BT	LR	NB	RF	NB	NB
German Cre.	BT	RF	BA	NB	LR				
Tic-Tac-Toe	BT	RF	BT	BT	LR				

Accuracy									
Dataset	Highest				Lowest				
	R	U	O	H	R	U	O	H	
Gamma Tel.	RF				RF				
Wilt	BT	BT	RF	RF	NB				
Bank Mark.	RF	BT	RF	RF	NB	BA	BA	BA	BA
German Cre.	RF	NB	BT	NB	LR				
Tic-Tac-Toe	BT				LR				

F-measure									
Dataset	Highest				Lowest				
	R	U	O	H	R	U	O	H	
Gamma Tel.	RF				LR				
Wilt	BA	BT	RF	RF	NB				
Bank Mark.	RF	BT	RF	RF	NB	BA	BA	BA	BA
German Cre.	RF	NB	RF	BT	LR				
Tic-Tac-Toe	BT				LR				

G-mean									
Dataset	Highest				Lowest				
	R	U	O	H	R	U	O	H	
Gamma Tel.	RF				LR				
Wilt	BT	BT	LR	LR	LDA	NB	NB	NB	NB
Bank Mark.	NB	RF	BT	BT	LR	NB	RF	NB	NB
German Cre.	BT	RF	NB	NB	LR				
Tic-Tac-Toe	BT				LR				

ROC AUC									
Dataset	Highest				Lowest				
	R	U	O	H	R	U	O	H	
Gamma Tel.	RF				LR				
Wilt	BT	BT	LR	LR	LDA	NB	NB	NB	NB
Bank Mark.	RF	RF	BT	BT	LR	NB	NB	NB	NB
German Cre.	BT	RF	NB	NB	LR				
Tic-Tac-Toe	BT				LR				

The used symbols in these tables are as follow.

- R – Before applying sampling approaches (Real case)
- U – After applying undersampling approach
- O – After applying oversampling approach
- H – After applying hybrid approach

According to the Table 4, the techniques RF or boosting have highest performances for the most of the cases in overcoming class imbalance aspect.

**IV. DISCUSSION & CONCLUSIONS**

When considering the resampling aspect, resampling was done to the whole dataset by changing the probability of success from 0.1 to 0.9. Though the dataset was balanced when success probability was equal to 0.5, there was no guarantee about the balance of training set. Here, for Gamma Telescope and Bank Marketing datasets the technique RF had the highest performance for all success probabilities. When considering all success probabilities, two techniques (RF and boosting) had the same highest performance for the Wilt dataset. In some datasets (German Credit and Tic-Tac-Toe), there was no one such method which could be considered as the best method for

all success probabilities. The obtained results suggested that either RF and boosting separately or both of them as the best methods for all success probabilities.

Also it was noticed that in resampling aspect, the G-mean and ROC AUC values, were approximately similar to each other in all five scenarios respectively. According to those two evaluation measures, almost all classification techniques had higher performance at middle probabilities (eg: 0.5) than the extreme probabilities (eg: 0.1 and 0.9).

In overcoming class imbalance aspect, the main focus was balancing only the training set not the whole dataset. Not like in previous aspect, there was an assurance that the classification techniques were trained by using a balanced training set. The sampling approaches such as undersampling, oversampling and hybrid approach (mix of both undersampling and oversampling) were used to balance the training set. The performance of classification techniques were analyzed individually before and after applying the sampling approaches to make the training set balanced under each dataset separately. The techniques RF and boosting had the highest performance for many cases in this aspect. Since the sampling approach which maximize the performance of classification techniques was depended on domain, the best sampling approach couldn't specifically mentioned.

Also majority of evaluation measures (precision, G-mean, ROC AUC) suggested that the performance of most classification techniques were higher after applying the sampling approaches. The evaluation measures, accuracy and F-measure had lower values after applying sampling approaches for most of the classification techniques. The performance of positive class may low due to issues such as loss of valuable information and over fitting in sampling approaches. Since the accuracy and F-measure are relied only on positive class, they might provide lower results after applying the sampling approaches.

Though LDA and LR are classical statistical techniques, they were sensible to sampling approaches. However for most of the cases, the performance of LR also had been improved after applying sampling approaches but sometimes it was considerably very low when compared to the performance of other techniques. That was probably due to the characteristic of domains. Not only the machine learning techniques, but also statistical techniques had higher performance by using the balanced training set.

Not only after training classification algorithms by using the balanced training set but also in resampling aspect, RF and boosting performed well for most of the cases. It might happened probably due to the sampling structure in their classification algorithm. When considering the obtained results, it is difficult to make a general conclusion about the best classification algorithm due to the dependency in performance of classification technique on problem domain.

When the classification classes are not equally represented (imbalanced) in dataset approximately, the accuracy of machine learning techniques are biased towards the majority class. That means if higher proportion (about 90% or above) of data belongs to one particular class (called majority class), then classification algorithm tends to predict the majority class often. Hence achieves highest accuracy while the decisions can be misled. Since the class imbalance was considered in both aspects, relying only on accuracy was not appropriate. That was the reason for using several evaluation measures such as precision, F-measure, G-mean and ROC AUC. When considering the precision, it is based on high performance of only one class. According to equation 5 and 6, F-measure is combination of precision and sensitivity while G-mean is combination of sensitivity and specificity. ROC AUC gives the area under the curve which represents sensitivity – (1-specificity) pairs. Though the F-measure was suggested as an alternative for the class imbalance, it was relying only on success (positive) class. The evaluation measures, G-mean and ROC AUC can handle the class imbalance scenario well as they consider the performances of both classes at once. Therefore, use of several evaluation measures was important as some of them can handle the issues like class imbalance and can provide much confident conclusions.

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# PREDICTIVE CUM ADAPTIVE SYSTEMS DEVELOPMENT METHODOLOGY FOR HYDRO GIS TOOL DEVELOPMENT

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**Abstract** - In system development methodologies, main consideration has been changed from processes to users since waterfall development. As the business logic became less complex due to familiarity; Extreme Programming methodologies like Agile and Scrum become popular among the programmers. Nevertheless, the engineering processes like hydrology modelling, which are still evolving, remain in the same complex. As well historically established hydrology calculations, which are base to evolving models, are remaining complex. When model development, hydrologists have to identify and sequencing those established calculations that best suited to the model scenarios. Then as the final step, they have to calibrate and validate the model, which takes considerable time and effort, before apply to decision making. Hence, once the models are crated, those cannot be changed very easily whilst the automation. As well as the programmers has to pay a considerable attention to the get the 100% accurate result. However, the most users of engineering applications are novice and required more user centric tools same as other users. Hence, there is a difficulty to develop such systems following either predictive (focus on process) or adaptive (focus on users) methodologies which presently available.

The present work's main objective is to identify and calibrate the most suited combination of methodologies to development of a HydroGIS (Hydrological Geographic Information System) tool, which should accurately automate the complex hydrology process in GIS environment whilst satisfying the user requirements.

Whilst developing the tool, it carries out two parallel developments (1) Automation of engineering process and (2) Achieving the user-friendliness. Whilst automating the processes, a comprehensive devotion was paid to calibrate the accuracy of the calculations. When achieving the maximum user-friendliness, a repetitive developing prototype was used. Once the both parallels come to the accepted level, it amalgamates the prototype with engineering processes. Then integration and system testing were carried out before releasing the final product. The developed tool named GIS2MUSCLE.

The HydroGIS tool which developed, demonstrates 100% accuracy in hydrological and GIS calculations whilst 92% user-friendliness in tool operation. Presently this calibrated methodology, which follows a process centric development to gain user centric tool (PcD.UcT), is being verified with six software development projects.

**Keywords** - Engineering System Development Methodology, HydroGIS tool, Predictive cum Adaptive

## I. INTRODUCTION

### A. System Development Methodologies

System Development Methodology refers to the approach in implementing the system development life cycle (SDLC) phases in the practical software development. Planning, analysis, design and implementation are the four basic steps of SDLC. In the planning phase, it identifies and

reasoning why the system should build and determining how it will go about building it. Through studying the present systems and identifying the problems & opportunities, team conceptualize the new system whilst the analysis phase. In the design phase, team finalise how the system operate by the means of functional and non-functional requirements. At the implementation stage, team builds the system. (Dennis et al., 2009)

These methodologies have being classified according to different perspectives. Following are few examples (1) Plan-driven/traditional or heavyweight and Agile/ lightweight (2) Predictive and Adaptive (3) Process centred and Data centred.(Dennis et al., 2009; Fowler, 2001; Picek, 2009). The present study considers the predictive (scope of the project can be expressed accurately) and adaptive (scope and requirements are difficult to clearly expressed early in the SDLC) perspectives.

## B. Engineering Applications

Engineering is a matured profession with experiences. Comprehensive planning, designing and drawing are inherent characteristics of the engineering process. Due to the failure-costs are immensely unbearable, the engineers invest considerable time and resources in these initial stages.

Once the software engineering profession emerge in 1960's, it was a subset of engineering profession which women's job (Meyer, 2013). In that time, planning, design, implementing and maintaining of the hardware was the main computing work whilst software development was a painting work. Since then, the initial software development methodologies such as waterfall and parallel development models emerge with the increasing of the software utilization in the computing. The phases in these development methodologies are based on same characteristics of general engineering process such as comprehensive study, design and then development.

Nevertheless, with the vast distribution of the users among the different knowledge level of computing, the user interface of the software required to be more user-friendly. As well due to the uncertainty of the requirements, the development of the software using predictive methodologies becomes hectic work. Then as a solution, adaptive development methodologies such as extreme programming, agile development versions got the popularity.

The automation of the engineering applications also subjected to same user requirement variations. The situations become worst, as the non-technical decision makers are prone to use the engineering applications when decision-making. As the engineering calculations become more complex with the development of profession, it needs more time and resource in the analysing, design and development phases. Therefore, engineering applications required predictive as well as adaptive development methods simultaneous which is not applicable.

## C. Hydro GIS Tool Development Methodology

The present work considers a HydroGIS tool, hydrological engineering application for urban decision-making. The decision-making users in the local authorities need to suggest and stress the public when urban land modifications for the purpose of urban flood prevention. Then a series of hydrological calculations need to be performed to evaluate the affect of modifications on the flood generation and select a suitable preventive option. As it is impractical to employ a hydrologist in the process, the requirement is to automate the hydrological calculations, which can perform by local decision makers. Then the automation process should allow users to incorporate land modifications in spatial format, perform hydrological calculation, display output in spatial format and opt a preventive option (Pradeep and Wijesekara, 2012).

Considering hydrologists are the most naturalistic environmental modellers. The hydrology models developed for natural phenomena are widely accepted and more established than other environmental models (Sui and Maggio, 1999). For the Sri Lankan context, most of the hydrology calculations based on the Ponrajah's guidelines published in 1980s, which have being successfully utilised since then. Such basic calculations, which verified, not only through data but also through time, have become the base for most of today's developing hydrology models. (Chemjong and Wijesekara, 2017; Dahanayake and Wijesekera, 2017; Keerthirathne and Wijesekara, 2017; Sakthivadivel et al., 1997; Thakuri and Wijesekara, 2017). Whilst hydrology model development, the most suitable set of established hydrological calculations is selected. Then the sequence of the calculations is being arranged to get the required results. Once complete the calculation process sequencing, start the model calibration with available data. Then calibrated model subjected to validate with the real time data. Automation of the process is allowable only after this process, which urged considerable



time and resource. Whilst the automation process, the results of each, intermediate to final hydrological calculations steps, has to be verified and confirmed to the standards and norms. Hence, automation becomes a process centric development, which need to carryout with close relation with hydrologists.

As well, hydrological models are based on the geographical distribution of features such as slope, soil, landcover, ground water levels, soil moisture etc. Therefore when perform the hydrological models it required to manipulate the geographic information too. For this purpose, GIS, a specific tool developed to manipulate the geographic information, become a supporting tool in hydrological model calculations (Maidment, 1992). Therefore, to receive the accurate result in automation of the hydrological models it need to develop coding not only for hydrological calculations but also for geographical layer manipulations. As the hydrological systems are based on time and GIS based on the space the automation process get more complex. Then developers need to develop codes with the consultation of the GIS professionals too.

Apart from the complex process, the potential users of the HydroGIS tool are varying from very few highly technical hydrologists to large number of non-technical decision makers like government officials in local government authorities. Importantly the decision makers required the accurate result with minimum interaction with the tools. Specially, decision makers need to make attribute modifications and viewing the intermediate results, calls trial-and-error process, to arrive the concluding

#### **D. The Problem**

Then the final problem is, how a HydroGIS tool that process and user-friendliness both are having same importance, can be developed accurately and satisfactorily.

#### **E. Objective**

Therefore, the main objective of the present work is to identify and calibrate the most suited combination of methodologies to development of a HydroGIS tool, which accurately automate the complex hydrology process in GIS environment whilst satisfying the non-technical user requirements.

## **II. LITERATURE SURVEY**

### **A. System Development Methodologies**

A large number of system development methodologies are available as shown in the table 1.0. All these methodologies based on the phases of system development cycle; planning, analysis, Design and implementation. As well, the waterfall method can be considered as the first most development methodology that extensively used in 1970s. As an alternative in 1980s, to satisfy the unsatisfied requirements in development the prototype evolved. Finally, when the “Requirements of users” evolved in 2000s the Agile methodologies were introduced (Avison and Fitzgerald, 2006). Therefore the methodologies shown in the Table 1.0 can be describe as the versions of waterfall and prototype developments.

When study the development methodologies, it can identify the attention has being changed from process automation to user engineering with the time. Nevertheless, it can be considered, waterfall methodology provides the foundation to all the methodologies. Even today, the popular methods like scrum show the features of waterfall and prototype methodologies. However, attention to the user requirement should have a limit. It has identified the user engineering may have a risk of excessive software development with gold-plating or bells-and-whistles or mission/feature/scope/requirement creeping. Then the repercussions may be negatively effect on system development project schedule, quality and cost (Shmueli and Ronen, 2017). Hence, a balance between process automation and user requirement satisfaction should to be maintained.

Therefore, the developers need to a make decisions to select the best methodology to their development process. When deciding the satisfaction of promises (expected positive impacts) and practises (essential steps of methodology) of the selected methodology to the developers’ requirement is important. There are number or evaluation mechanism such as Cost-benefit analysis, Scoring evaluation, Feasibility study, Value Analysis and Multi- Objective Multi-Criteria methods and so on are available (Mohagheghi, 2008). But the present work evaluate the methodologies based on much simple approach, analysis the ease of automating the process as well as user requirements. Then the suitability of the each approach for the HydroGIS tool development is shown in the Table 1.0.

**Table 1.0 System Development Methodologies**

Srl	Meth <sup>1</sup>	On <sup>2</sup>	Suitability for Hydro-GIS tool
1	Waterfall	P	Best suited for process automation, difficulty incorporate user requirements later
2	Prototyping	U	Best for user friendly development, effects on workflows
3	Iterative and incremental	P	Shorter waterfall steps, but difficult in incorporation of user requirements
4	Spiral	P	The methodology is based on risk reduction
5	Rapid application development	U	Time boxing approach based on fulfilling the requirements
6	Extreme programming	U	Directly automate the user requirements
7	V-Model	P	Based on the testing, difficult in user requirement facilitation
8	Scrum	U	Rather small projects and scrum based
9	Cleanroom	U	Iterations with box structure
10	Dynamic systems development	U	Time boxing approach based on fulfilling the requirements
11	Rational Unified Process	U	A complicated system with iterative development
12	Lean software development	U	Automate the minimum requirements with users
13	Test-driven development	U	Development based on the testing
14	Behaviour-driven development	U	User behaviour centric
15	Feature-driven development	P	The larger project development process which is having less complex processes. Need a complete staff of developers
16	Model-driven engineering	P	Model oriented automations, user requirements are difficult to handle
17	Crystal Methods Methodology	U	Develop based on the developers capability over user requirement
18	Joint Application Development	D	Developer centric, not much describe as a development methodology, but as a tool
19	Adaptive software development	U	Based on User requirement satisfaction
20	Open source software development	D	Developer centric, not much describe as a development methodology, but as a tool
21	Microsoft Solutions Framework	D	Developer centric, not much describe as a development methodology, but as a tool
22	Agile Development	U	A adaptive approach based on the user requirement satisfaction
23	Scrum	U	A adaptive approach based on the user requirement satisfaction, development of agile methodology
24	Kanban (Just-in-time)	P	Provide the most required part of the software to the correct time with quality. Based on pre defined user requirement.

**Meth<sup>1</sup>: Methodology On<sup>2</sup>: Focus on**

**U: User P: Process D: Developer**

**Source: Author after Despa, 2014; Jamsheer, 2016;Leiet al., 2015**

**B. HydroGIS Tool Requirements**

Pradeep and Wijesekara (2012) study has found that a requirement to develop a HydroGIS tool to manage the urban flash flood. Hence urban flash flood is a repercussion of urban land allotment modifications, the tool need to identify the affect of the modification on the stormwater generation. Further tool should allow the users to arrive dynamic engineering solution to manage excess stormwater. They have identified three process modules to carryout the entire task, (1) Incorporation of land parcel modifications (2) Calculated storm generations pre and post scenarios (3) incorporation of detention pit. This tool urged to have a user centric map based interface with on-screen capability in data input and dynamically modify the attributes/land parcel modifications. As well due to the manipulations are done in rather smaller urban land extents, the accuracy of the results becomes sensitive. The Important factor is, the potential users of the tool are non-hydrological land managers.

**C. User Centric Design**

As the users feel User Interface is the System, development of user interface for tools are very important. User-Centred Design (UCD) is the process of designing a tool, from the perspective of how it will be understood and used by a human user which formulated around 1980s. To learn the software users have to adapt their attitudes and behaviours. But when UCD, the software designed to assist potential users' existing attitudes, and behaviours. To achieve this, it places users at the centre of the design process from the stages of planning and designing the system requirements to implementing and testing the product. This result an efficient, satisfying, and user-friendly tool. (Abramson et al., 2004; Baek et al., 2008)

The user experience design (UXD) and usability are the other two terms with the UCD. UXD needs to understand the users through a research. The research includes user observations, interviews, and different techniques to capture the users' emotions, motivations, and underlying concepts and beliefs. Then this knowledge will be used to develop user interfaces which align and support user behaviour. Usability is a measure of the interactive user experience associated with a user interface. It is a evaluation of user-friendliness which is easy-to-learn, and easy-to-use capability. The usability measures evaluating the users capability of use of the tool without any assistance. For the evaluation there are number of methods such as heuristic,

cognitive walkthrough, Formal usability inspections, Pluralistic walkthroughs and etc; are available. The main aim of the usability evaluation is find the problems in user-friendliness and fix those before release the final product. ("Introduction to User Centered Design," 2017; Nielsen and Molich, 1990; Nielsen, 2012, 1994)

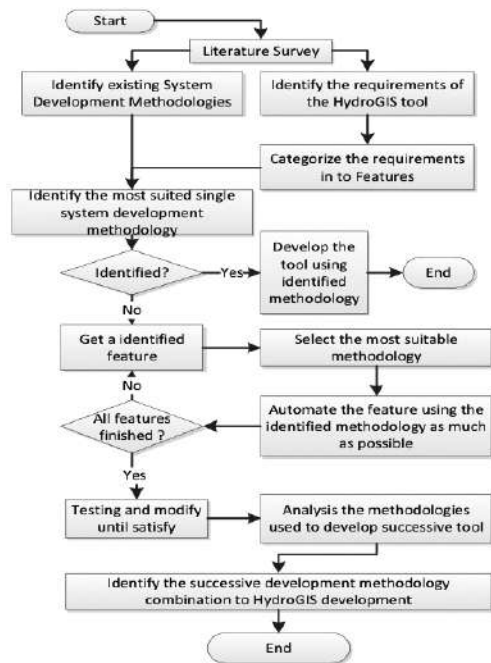


Figure 1.0 Overall Development Methodology

**III. METHODOLOGY**

**A. Overall Methodology**

The present work methodology flowchart is shown in the Figure 1.0. The work starts with the comprehensive literature survey to identify existing system development methodologies. Then, it identifies the requirements of the tool such as user needs, data needs, process / calculation needs and technology needs. After that, it categorises those requirements in to different features. In the next step, it analyses the system development methodology over the tools requirements to identify which methodology to be used. If it could be able to identify the methodology, then follow the same. Else, identify the suitable methodologies to automate the categorised feature by feature. Once all of the different features automated, integrate them together and carryout integration, system and acceptance testing till reach the satisfactory level, before release the tool.

Once the tool release, progressively scan through the methodologies practises to develop the tool and identify successive path to development of an accurate and user friendly HydroGIS tool.

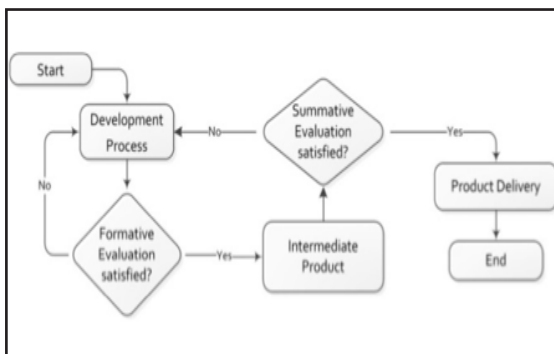
**B. User Requirement Automation with Prototype**

When user requirement automation, the tool underwent three kinds of user evaluations; software adequacy, formative and summative evaluations as shown in the Figure 2.0. Through the requirement analysis, it identified the basic functionalities of the tool then a prototype was developed. The developing prototypes were evaluated with the users through questionnaire. The objectives of the evaluations are shown in the Table 2.0. This software adequacy questionnaire evaluates the useability of the initial functions of the tool. Then with the user commented modifications second prototype was developed and again it was tested two times, which until satisfy the users. The acceptable prototype then integrated with the calculations modules. The final system was subjected to perform a summative evaluation. In the each evaluations, the tool was modified based on the view of usability. These process and the evaluations were align with the National Research Council (2007) guidelines of human-system integration in system development process.

**Table 2: Basic Requirements gathered from the questionnaires**

Basic Requirement	Question target to acquire the Users' satisfaction on
Assess the achievement of Objectives	Installation of the tool, Start the tool , Layer selection, Modify the selected layers and attributes, Update modifications , Modification of onscreen map and attributes, Do the modification in all four layers, Printed outputs generation, Secure the operation
Assess the usability of the developed GUI with GIS concepts / usage	Ease of navigation, Zooming and panning, Scale facility, Permit the user to navigate while keeping track of current reference frame, Provide tools for capturing, editing, and printing maps, Map in a larger percentage of the screen area
Assess the General Principles of GUI development	User centred design , Visual clarity, Consistency, Explicitness, Appropriate functionality, Flexibility and control, Error prevention and correction, Compatibility / Portability, User guidance and support, Informative feedback

Source : (Pradeep and Wijesekara, 2015)



**Figure 2.0 Prototype Development Process**

**C. Process development with waterfall development**

In the calculation process automation, it identified the required hydrology models and calculation sequences. As well, a specific attention paid to automate the dynamic calculation modules. For that, it incorporates Rational Method to calculate composite runoff coefficient. As well, the concept of inflow hydrograph attenuation is being used to determine the detention storage size (Pradeep and Wijesekara, 2012). These two complex processes run based on the inputs from not only users or results of intermediate calculations but also GIS manipulation outcomes. Then the entire process run through manually and all the final and intermediate results were recorded in excel sheets. This process can be considered as the study the manual system and identify the bottle-necks in exiting system which is a step of waterfall development. Then automation started and each step evaluated against the results in the Excel sheets for accuracy. This become more difficult work, as once it found the errors in the manual system, then the

manual system has to perform from the very beginning and as well, the automation had to reengineered. Then a considerable time spent to evaluate the manual process then start the automation. A module level evaluation of the software output against the manual results carried out throughout the automation. The development of foresaid excel sheet was a different research of University of Moratuwa.(Wijesinghe and Wijesekera, 2010)

**D. Integrating the User Centric Tool with Process Centric Algorithm**

Once the user friendliness reach to a acceptable level, 70%, and need to integrate the process for further evaluations, it decided to stop prototype modification. But the process automation carryout until reach 100% against the recoded set of results. Once it satisfied the process accuracy condition, then integrated the user interfaces with the process codes which have developed using same languages on same platforms. Whilst the integration, the user modification requests received at the 70% satisfaction level, were incorporated and went to the final summative evaluation.

**IV. RESULTS & DISCUSSION**

**A. The development model - Process Centric Development to User Centric Tool (PCD.UCT)**

Once the satisfied tool resulted, it evaluates the software development methodology, which it has actually practised. Then it could be able to identify a hybrid development of waterfall and prototype development. The user centric tool development shows the characteristics of prototype development whilst the process centric algorithm development process shows the characteristics of waterfall development. The practised and proved software development methodology was named Process Centric Development to User Centric Tool (PcD.UcT) model and shown in the Figure 3.0.

**B. User Centric Tool**

The HydroGIS tool which developed through the described process shows a 92% user acceptance as shown in the Table 3.0. User evaluation 1,2 and 3 were performed during the user centric tool development and final evaluation was done at the optimization evaluation after the integration of prototype to process algorithms.

**C. Process Centric Development**

The result has shown the followed methodology could be able to provide 100% of the process. It has tested 80 test cases whilst the algorithm development and optimization evaluation. Result of five samples out of 80 carried out at the optimization evaluation are shown in the Table 4.0.

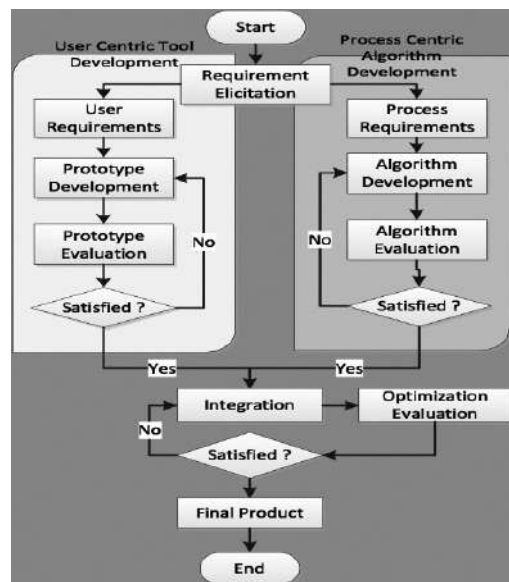


Figure 3.0 Pcd.UcT Development Model

**Table 3: Evaluations Result**

Srl	Main Considerations and attributes	User Friendliness Evaluations			
		1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>nd</sup>
1	Continuity in Operation				
	Process Liberty of other GIS functions	70%	70%	78%	90%
2	Error handling & Accuracy Confirmation				
	Error prevention and correction	70%	72%	78%	98%
3	GIS software version Compatibility				
	Compatibility / Portability	70%	78%	78%	99%
4	Information Security				
	Spatial Data Security	0%	0%	35%	89%
5	Non-GIS User Operation Capability				
	Update modifications	80%	80%	80%	97%
	Flexibility and control	70%	70%	79%	88%
	Appropriate functionality	68%	70%	77%	90%
	Modify the selected layers and attributes	68%	77%	77%	97%
	Explicitness	67%	75%	76%	97%
6	Easy operation Capability				
	User centered design	65%	65%	73%	88%
	Consistency	55%	69%	71%	89%
	Informative feedback	5%	68%	70%	99%
	User guidance and support	3%	40%	49%	90%
	Printed outputs	3%	30%	43%	95%
	Provide tools for capturing, editing, and printing maps	3%	30%	43%	91%

7	On-Screen Operational Capability				
	Ease of navigation	70%	75%	78%	86%
	Scale facility	69%	75%	78%	90%
	Zooming and panning	68%	75%	78%	89%
	Modification of onscreen map and attributes	67%	72%	75%	93%
	Visual clarity	65%	68%	73%	98%
	Map display size	5%	65%	67%	89%
8	Tested and Verified Results				
	Modification in all required layers	65%	70%	75%	85%
Average		50%	63%	70%	92%

Source : (Pradeep and Wijesekara, 2015)

**Table 4: Evaluation accuracy result**

Test case No	Runoff coefficient (manual method)		Runoff coefficient (Tool)		Accuracy	
	Before Mod:	After mod:	Before mod:	After mod:	Before mod:	After mod:
1	0.548	0.695	0.548	0.695	100%	100%
2	0.984	0.816	0.984	0.816	100%	100%
3	0.327	0.364	0.327	0.364	100%	100%
4	0.228	0.389	0.228	0.389	100%	100%
5	0.200	0.376	0.200	0.376	100%	100%

**D. Effect on Software Project Management**

According to the practised development model (Figure 3.0) it has identified three different phases (1) Requirement clarification (2) Development and (3) Evaluation and modification. The recoded average weeks (1 week is equal to 14 hours effort of a programmer) taken for each phases are showing in the Table 5.0.

The Requirement Clarification of Prototype was taken much shorter time than the Process Development, as the requirement clarification is in the Process development was a hydrological model development activity.

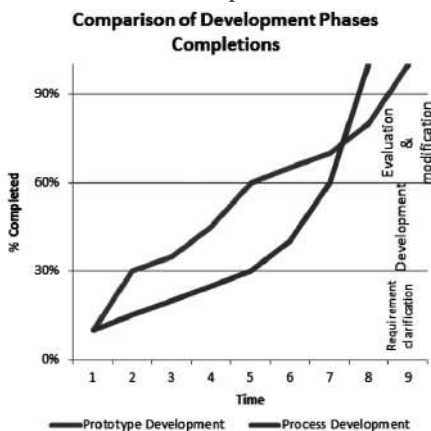
In the development, it took average equal time for both development processes. However due to the requirement of following standards such as user-friendliness development and usability guidelines, prototype taken much longer time.

Whilst the evaluation, Prototype was taken longer time not only as it need to meet the users and get the feedback, but also need to satisfy users requirements which arises at each evaluation.

**Table 5: Average Weeks Taken to Complete Phases**

Phase	Prototype Development	Process Development
Requirement	2	5
Development	3	2
Evaluation	4	1

Considering the all three phases are having equal weights towards the completion of the development described in this sub section, Figure 4.0 shows the comparison of phases of two different developments over the time.



**Figure 4.0 Development process completion comparison**

**E. Discussion**

The present work attempted to develop the codes for process whilst developing the model. Then the work had trouble in time-taken reengineering with re-coding when a model has to correct. Hence, it has realised that requirement of tough patient, until the model development finish to start the coding of the processes / calculations.

Then without wasting time for model calibration, the work started the user interface development and evaluations for usability. Nevertheless, before finalise the prototype, sub process module out of 3 process modules were available to automate.

Then the present work started automates the process modules parallel to the prototype development that realised the methodology is an innovative use of available methodologies.

Even the model developers confirm the completion of the modules' accuracy, the work did not develop the user interfaces with the process automation, but carried out the automation of processes in software modules which can fix to prototype at anytime.

The work realised that, in each user evaluation a new user requirements are creating which are out of the scope of development. Due to this scope creeping requirements, more than 70% user friendliness was considered as an acceptable level to conclude the prototype development.

Once integrating the user interface to the developed process the final summative evaluation or the optimization evaluation was carried out. Then, as the tool is providing the actual results and satisfied the observations, which users made at the 2nd formative evaluation, user acceptance raised to 92%.

The processes and prototype were integrated once the acceptable levels of each reached. Then the expected errors were with only coding problems in integration. As it uses standards, publicly expressed variable descriptions and module level algorithm development, it was became easy task.

The time taken information in the Figure 4 shows late completion of the prototype development after the process development. Due to the two different natures of developments, it is not reasonable to match each other. However, Figure 4 shows the development phases of two developments start one after other. Hence this parallel

development methodology utilise the developer for coding continuously which results early Software Development Project completion.

## V. CONCLUSION

The present work practised a hybrid development methodology, UcT.PcD, a combination of waterfall, prototype - repetitive development methodologies. This was a two parallel phased development methodology, (1) automate the engineering process through waterfall development and (2) develop the user interfaces using prototype - repetitive development methodologies. Once the accuracy reach to maximum and user-friendliness reach to a accepted levels, the two set of codes were integrated. The final evaluation carried out to confirm the success.

Then the present work demonstrate the capability of combine the approaches in system development methodologies that are following entirely different sequence to achieve the required outcome if the developers understating the desired outcomes.

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# MACHINE LEARNING OPTIMIZATION FOR COLOUR IMAGE RECONSTRUCTION FROM THERMAL/INFRARED IMAGES

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**Abstract** - Machine Learning has generated a tremendous interest in research and development under the umbrella of Artificial Intelligence. It was a field that evolved from pattern recognition and computational learning in Artificial Intelligence. Machine Learning algorithms are capable of identifying how to accomplish certain tasks by generalizing from real world examples. In comparison to manual programming, this is often feasible and cost-effective. In this context, this paper focuses on the use of these optimized machine learning algorithms in order to reconstruct colour images from thermal/infrared images. With the capability of these machine learning algorithms to identify patterns in existing data sets, such an algorithm can be used to reconstruct a colour images based on the features that are given to the algorithm. Most night time photography uses thermal imagery because of its capability of capturing thermal radiation from the human body. So these data can be used to reconstruct a colour image based in feature recognition form the thermal image. In conclusively it is our intention to use the power of machine learning techniques to build a system that can generate colour images by analysing the small amount of details that are present in thermal images.

**Keywords** - Thermal Imagery, Facial Image reconstruction, Machine Learning

## I. INTRODUCTION

Machine learning field and machine learning algorithms have gained immense popularity due to its capability of improving itself through experience[1]. It has become one of the most growing technical fields being nurtured by a mix of computer science, data science, statistics and artificial intelligence. Machine learning algorithms are capable of identifying patterns and how to accomplish certain tasks by generalizing from the real world examples. It all depends on the amount of data that is being fed to the algorithms. More problems can be tackled as more and more data is available. This is one of the interesting adoptive properties of machine learning algorithms. This is often feasible and cost effective. Machine learning is used in Web search, spam filters, stock trading, recommender systems, fraud detection, ad placement, credit scoring, drug design, and many other applications.[2] Under the umbrella of Artificial Intelligence, machine learning has flourished as the method of developing systems such as speech recognition, natural language processing, robot control, computer vision and many other things. Training a system with examples of desired input-output behaviour has become more feasible than to program and algorithm to anticipate a desired output based on all possible inputs. Machine learning algorithms can be used to tackle learning problems. Learning problems can be defined as an improvement of the threshold of performance when executing a task over and over again and there by learning from it. For example, a machine learning algorithm

trained to differentiate between male and female faces which will flag a given image, whether the person is a male or a female, will improve its performance over time when encountering more and more data sets and through processes such as active learning.[3]

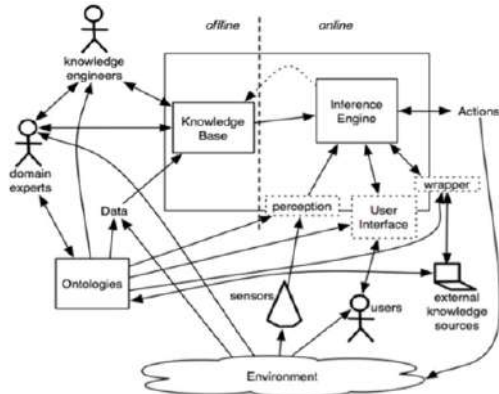


Figure 1 Machine Learning Mechanism

The focus of this paper is the use of these machine learning techniques to understand the minute details of the face image data from thermal images of human faces and using the machine learning optimization to build a colour image model of the face. When the thermal image is submitted to the algorithm, it will analyse for the features of the image and based on the existing knowledge base that it has, it will reconstruct a face based on the data. Thermograms are the images that are generated by detecting radiation in the long infrared range of the electromagnetic spectrum. A thermal infrared camera is being used for this purpose. Simply said, the camera can identify the heat signatures emitted by any object that is inside its view finder. After pre-processing the thermogram using image processing techniques, certain physiological features can be extracted based on the blood perfusion data. Blood perfusion data are based on the way that blood vessels are distributed under the skin. Distribution of blood vessels is unique for each individual and a set of extracted minutiae points from a blood perfusion data of a human face would be unique for that face. So these unique features will assist in reconstructing the facial data and finally output a facial image of a person.

## II. EXISTING SYSTEMS

Biometrics is a Greek origin word meaning measure of life. It means that the measures or the metrics that we take of the human beings. Facial data analysis is a part of this field.

Biometrics use various physical characteristics to match with the data in the database.

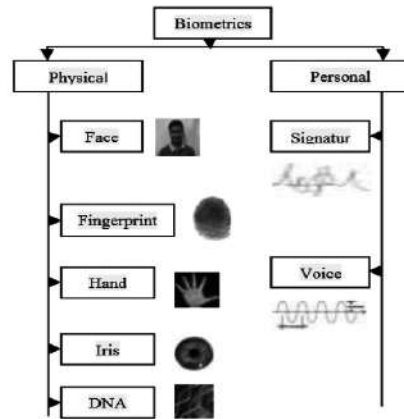


Figure 2 Biometric Uses

Abundantly used physical biometrics are fingerprints, facial features, hand geometry and eye features etc. Among these many biometric measures, facial detections are a significant trait that is being used in the modern world. One significant importance is that no physical interaction is needed for facial images to be used. The system can capture the facial image of a person while a person is walking through a door or while he is standing, there by revoking the requirement for the individual to touch a panel, keep a fingerprint of any other physical interaction. In comparison of visual images with thermal images, the visual images have a higher preference in many aspects. Following can be considered as a few set of advantages of visual images.

- Location and extraction of features can be done easily.
- Optical cameras are less expensive.

But factors like illuminations and viewing directions have a noteworthy impact on these visual images[4]. One solution to overcome these limitations is using 3D data obtained from 3D vision devices. They are less independent on illuminations but the downside to it is the massive cost. So a simple, feasible solution to this would be infrared or thermal images which do not depend on illuminations and other factors. Colour which comprises the longest wavelength of the visual spectrum is red. "Infra" which means below in Latin suggests that Infrared is below Red.

The wavelengths of different IR spectrums are shown in the following table[5].

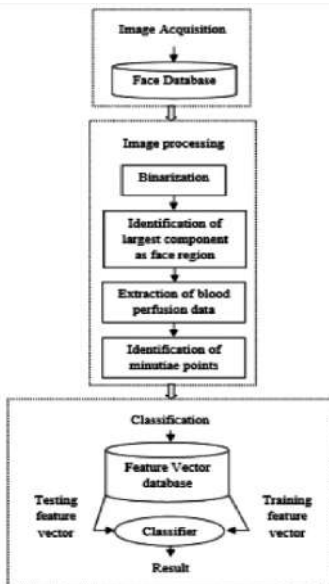
Spectrum	Wavelength Range
Near-Infrared (NIR)	0.7-1.0 $\mu\text{m}$
Short-wave Infrared (SWIR)	1-3 $\mu\text{m}$
Mid-wave Infrared (MWIR)	3-5 $\mu\text{m}$
Thermal Infrared (TIR)	8-14 $\mu\text{m}$

**Figure 3 Wavelength changes for different IR Spectrums**

Following mentioned advantages can be obtained from using thermal imaging.

- The cost of IR cameras has been reduced recently due to the implementation of CCD (Charged Coupled Device) technology[6].
- Different lighting conditions doesn't affect thermal imaging, even complete darkness.
- IR face images contains details about the basic anatomical information about the face.
- Facial detections, localizations and segmentations are much easier.
- Has much better accuracy because it uses facial temperature variations.

In relevance to current thermal imaging systems, they can be classified into three main parts namely, image acquisition, image processing and classification.



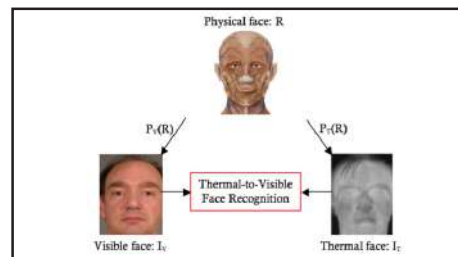
**Figure 4 Block diagram of a present system**

### III. TECHNOLOGIES USED

There can be various scenarios where visual images become un-resourceful and are incapable of meeting out certain requirements. Specially for night time surveillance imagery, acquisition of visible light images is a bit difficult due to the lack of visible light. This is the place where thermal imagery plays a major role. Thermal imaging which uses mid-wave or long-wave infrared radiations which are naturally emitted by the human body can be utilized to overcome the shortcomings of visual images. The drawback here is that thermal images lack the wealth of information that is available in visual images and hence it is difficult to identify features like facial cues in a thermal image to recognize a person. So this section focusses on the technologies that are used to develop a system that uses machine learning algorithms to study features that are common to visual and thermal images from a set of data and try to reconstruct a visual image of a face from a given thermal image. Matching thermal face imagery to the existing databases of facial images therefore requires the development of across modality face recognition algorithms and methods.

Due to the gap caused by the wavelength difference between visible radiation and thermal radiation, thermal to visual face reconstruction can be challenging. The existing systems[4], [7], [8] sectioned detailed about the usage of NIR images vs visual images for facial recognition. Details about the NIR-to-visible[9] face recognition and the SWIR-to-visible[10] face recognition was also briefly described. Since both NIR and SWIR require active illumination it is not very practical to night time surveillances.

The key point in solving the thermal-to-visible imaging drawback is the development of an algorithm or transform space that well-correlates the thermal and visible face signatures.



**Figure 5 Illustration of visible and thermal representation of the physical face**

Here our main focus is the matching of thermal images to visual images so that the machine learning algorithm can be trained to analyse and detect patterns between the two image domains. We convert this face identification problem of matching thermal images to visible images as a multi-modal face recognition problem. Before tackling this, various pre-processing techniques such as self-quotient[11] images, difference-of-Gaussian[12] filtering and various feature transforms are being used.

**A.PRE-PROCESSING**

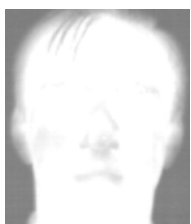
Due to the different signatures that thermal and visual images contain, pre-processing is essential in finding a solution to the problem. Pre-processing consists of two main stages. Namely,

- Thermal image normalization, and
- Local variation reduction for thermal and visible imagery

Simple median filtering prior to image normalization is used to remove the dead pixels within the thermal images.

Step 01: Normalizing thermal signatures

Normalize the thermal signatures by its mean and standard deviation to reduce the temperature offset and statistical variation across thermal images.



**Figure 6 Original Image**



**Figure 7 Normalized Image**

Step 02: Adjusts the thermal and visible imagery for local variations.

For visible imagery, illumination primarily induces the local variations, whereas for the thermal imagery, the varying heat distribution within the face produces the local variations. Self-quotient image and difference of Gaussian

Filtering is commonly applied to reduce illumination variations in visible face imagery.

**B.FEATURE TRANSFORMS**

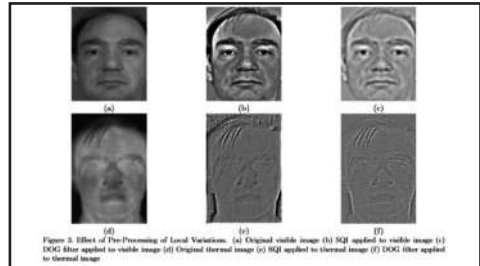


Figure 3. Effect of Pre-Processing of Local Variations. (a) Original visible image (b) SQI applied to visible image (c) DOG filter applied to visible image (d) Original thermal image (e) SQI applied to thermal image (f) DOG filter applied to thermal image

Computer vision applications is crucially dependant on the selection of good features. There are many feature descriptors available to facilitate face recognition. Local Binary Patterns (LBP) is a popular texture and a successful feature descriptor under local illumination variiances. LBP are compact and can be easily compared by various histogram metrics. The most popular extension is multi-scale LBP (MSLBP) descriptor.

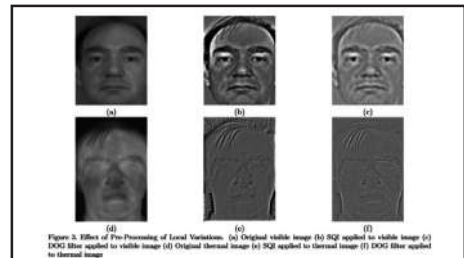


Figure 3. Effect of Pre-Processing of Local Variations. (a) Original visible image (b) SQI applied to visible image (c) DOG filter applied to visible image (d) Original thermal image (e) SQI applied to thermal image (f) DOG filter applied to thermal image

The above figure shows two pre-processed images along with the original images in the visible and thermal domains. As can be observed, SQI emphasizes the edge information in the thermal imagery while DOG filtering blurs the visible imagery. The Gabor wavelets are also effective face descriptors which capture global shape information centred on a pixel. The convolution of multiple Gaussian-like kernels at different scales and orientations captures information insensitive to expression variation and blur at a pixel's location. We consider all these features for thermal-to-visible face recognition. We also compare the results of using raw intensity values as a feature as in some previous works.

**IV. DISCUSSION**

Performing basic pre-processing consisting of dead pixel removal, affinely warping the face by four fiducial points (two eyes, nose tip, mouth), cropping to face regions,

and resizing to 80x100 pixels gives a much better way to generate visual images from thermal images. All these techniques gave a proper insight as to how the task of thermal image reconstruction should be accomplished.

## V. CONCLUSION

In this study, I have investigated the thermal-to-visual image reconstruction. The novel combination of pre-processing, feature transforming and PLS-DA recognition framework gives promising results with a high accuracy. A data set of these visual images and their corresponding thermal images can be fed into a machine learning algorithm which can be trained to analyse the patterns between those image pairs. Thus, that algorithm will be able to generate a new visual image for a thermal image that is provided. In conclusion these techniques can be used to implement a machine learning algorithm that can reconstruct a visual image based on the thermal image that is being provided to the algorithm.

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# A MACHINE LEARNING APPROACH TO CLASSIFY SINHALA SONGS BASED ON USER RATINGS

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**Abstract** - In the music industry there is a need to analyse the significant features that distinguish highly rated songs from lower rated ones. Then an artist can test their music tracks to check whether it will gain potential popularity, before mass production and if the rating is lower they can focus on the significant features present in popular tracks. Our study address this by developing a machine learning approach to classify music tracks based on user ratings. There were many research performed in the area of music genre classification, music recommendation using vanilla neural networks, recurrent neural networks and convolutional neural networks. The research mainly focuses on the classification of Sinhala songs. Our dataset is consisting of 11,000 Sinhala music tracks each having several attributes. From each track we extract 3 meaningful features. For the feature extraction process we used a python library. The output has three distinct classes that specify the user rating. A Multi-layer neural network was implemented. 500 training epochs with 60 neurons in each hidden layer were used. Initially, with 3031 training tracks and 1299 testing tracks we achieved an accuracy of 86%. With this, we conclude that the development of a multilayer neural network to automate the process of determining the rating for a song is in a successful stage compared with the existing approaches.

**Keywords** - Artificial Neural Networks, Classification, Clustering, Feature Extraction

## I. INTRODUCTION

Music has a great influence on humankind from reducing stress to enhancing cognitive power of human beings, While conveying strong messages as well as feelings to the audience in a unique manner. According to forecasts done by PriceWaterhouse Coopers, the global music industry is supposed to generate 47.7 billion U.S. dollars in revenue by 2020.(Statista,1 May 2017) In this type of promising market musicians can easily benefit given that they can satisfy audience expectations. In the context of Sinhala music it has the influence of many cultures such as the British, Indian and Buddhist.(wikipedia,1 May 2017) With these influences the music developed in Sri Lanka has greatly evolved and as a result of this evolution today we experience a more unique production of music. In the past the music produced was more of classical type while modern music incorporates a highly sophisticated level of beat patterns as well as a variety of instruments which generate powerful and complex tones. With the improvement in technology the music industry has taken a huge step forward with more convenient ways to produce, manipulate as well as generate music for the ease of musicians. With these developments in this industry it has made it extremely difficult to analyze and interpret user preferences thus leading to many musicians to fail in the industry while a few highly dominate the industry through their gifted talent. Through research done by a collaboration of the following universities and institutions,

McGill University, the University of Cambridge, Rutgers University, City University of New York, and the Stanford Graduate School of Business, They have found out that any music produced can be effectively categorized with the use of three significant features which are Arousal (intensity and energy in music), Valence(Spectrum of emotions in music) and Depth(Intellect and sophistication in music). (Digital Music News,1 May 2017) There are many research which mention different types of characteristics of music that determine user preferences. But there are no proper tools that have been implemented to successfully provide a solution to this problem of determining the potential user rating for a given song based on the underline characteristics. As a rating determines the success of the music track inability to effectively determine the rating will be a barrier to determine the success of a music track. Without any awareness of the success of the product a musician( especially for amateurs) may not be willing to enter the industry or may leave the industry, because of this the objective of our study was to develop a multilayer artificial neural network to successfully determine the rating of a given Sinhala song. In this process of determining the rating we also optimize the algorithm(s) and source code to provide a more efficient and accurate result.

## II. METHODOLOGY

There are extensive research done in the area of music genre classification and sound classification. In a research done by Aaqib Saeed, used machine learning to classify urban sounds to its relevant classes. He used a dataset which consist of various 8732 urban sounds each consisting of duration of 4s separated in to 10 folders from www.freesound.org from which first three folders were used for training and testing purposes. The dataset has 10 classes which are air conditioner, car horn, children playing, dog bark, drilling, engine idling, gun shots, jack hammer, siren and street music. The features that were extracted with the use of a python library known as Librosa and these features were melspectrogram, mel-frequency cepstral coefficients, chroma-stft, spectral contrast and tonnetz .

The extracted features and labels were fed to a multi-layer neural network on the training data. And the testing data were later fed after completion of the training. And here only the features of the testing set were provided to the neural network and the network was supposed to predict/ determine the relevant label pertaining to the given features based on prior learning experience. The accuracy

is calculated based on the number of correct predictions over the total testing set.

They have used Gradient Descent Optimizer which is an optimisation algorithm used to reduce the cost by a fraction of the learning rate during the training process. Thus optimizing for higher accuracy. Tensorflow has been used in the development of the neural network and the cost function they use is the cross entropy function.

This system does not provide an acceptable level of accuracy. It only has an accuracy of approximately 12% and further the computational cost of this implementation is significantly high(Saeed,1 May 2017).

In a research done by Carlos N. Silla Jr., Alessandro L. Koerich, and Celso A. A. Kaestner which was to automatically classify music into genres. In this system they use multiple feature vectors and pattern recognition techniques. A set of binary classifiers which produces the final result/genre based on a merge of multiple attributes were used to obtain result which were afterward merged to determine the genre. Most popular machine learning algorithms such as k-nearest neighbors, support vector machines, Naive-Bayes are some of them which they used. An important feature identified through their research was the most significant features used for the classification task depended on the origin of the music signal(Carlos N. ,Koerich and Silla Jr,2008).

In a music genre classification research done by Michael Haggblade, Yang Hong and Kenny Kao. In their research they have discussed about three classification algorithms which are k-means, multi-class SVM, and K-Nearest Neighbor(KNN). further they have chosen four classes(jazz, classical, metal, pop) of which one will be assigned with the output. They have used Mel Frequency Cepstral Coefficients(MFCCs) as their feature. They have also extended their system to cluster music into genres based on image features. They have performed the extension using k-means algorithm for clustering and Fourier-Mellin 2D transform to extract features. They have noted an important fact which is that the accuracy decreases if the number of classes exceeds 4. They stated that K-means algorithm faced a huge difficulty in distinguishing between classical and jazz. thus leading to 36% misclassification. They have stated that when considering overall accuracies the KNN and K-means displayed similar accuracies of 80% while the SVM gave them a 87% accuracy and finally the neural network giving them a 96% accuracy(Kenny Kao , Michael Haggblade and Yang Hong ).



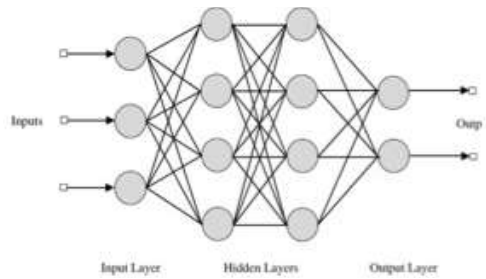
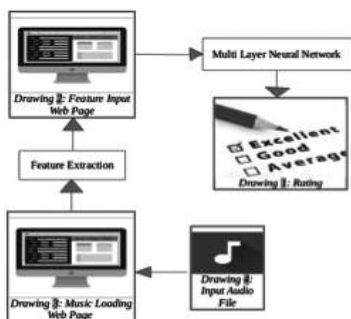
In a research done by Sam Clark, Danny Park and Adrien Guerard, they have used eight summary features, growing neural gas (an algorithm for reducing the computational costs when using a complex neural network) and a neural network for music genre classification. They have considered five classification classes as rap, reggae, classical, and country. Their hypothesis was that the growing neural gas would lead to an improved classification accuracy. This hypothesis was proven to be true with the receipt of nearly 14% increase in training accuracy and a 3% increase in test accuracy (Adrien Guerard, Danny Park and Sam Clark, (2012)).

In a research done by Cory McKay using neural networks for music genre classification, he has developed a system which can automatically classify MIDI files into hierarchically organized parent genres and sub genres. For his classification he has used primarily twenty original features and achieved an accuracy of 85% for parent genres and 65% for sub-genres(Cory McKay).

There also exist research done by Bo Shao, Dingding Wang, Tao Li, Mitsunori Ogiyama in the area of music recommendation. They state that collaborative filtering and content based recommendations are the most popular and recommended methods for music recommendation. But the aforementioned researches see some significant disadvantages of these methods which leads to an ineffective recommendations been made. These disadvantages are, the collaborative method will be effective only if we use a large dataset that consist of user history of user activity on the web. And the content based method lacks the ability to identify user preferences and interests. To overcome these limitation they propose a novel approach which takes into account content features and user access patterns(Bo Shao, Dingding Wang and Tao Li, (2009)).

**B. Conceptual Design**

The following diagram describes the entire process of determining the rating for a given song.



**Figure 2: Architecture of the multi-layer neural**

tempo, MFCC and harmonic element. The hidden layers do the processing and outputs the relevant label(excellent,moderate,poor).

**C. Approach**

1. Users: Any artist or music listener who would like to determine the rating of a given song.
2. Inputs: The 3 extracted features from the audio file.
3. Process:There will be a web page which will provide the user with the facility to upload their audio file and then the feature extraction method will run in the back end and display the extracted feature vector on the web page's output area.

Then the user can input this feature values to the neural network available on another page to determine the predicted rating for the input vector.

**D. Implementantion**

1. Creation of the datasets and preprocessing

The dataset contains 11,000 mp3 music files from a variety of musicians, genres and centuries. This diversified dataset is a good representation of the entire population of Sinhala songs.

First we would extract the features from each of the audio file and save it to a CSV file. So that it would be computationally less expensive compared to processing the audio files for feature extraction during program execution.

```

1#feature extraction method
2def extract_feature(file_name):
3    X, sample_rate = librosa.load(file_name)
4    onset_env = librosa.onset.onset_strength(X, sr=sample_rate)
5    #beats per minute(tempo)
6    tempo = np.mean(librosa.beat.tempo(onset_envelope=onset_env, sr=sample_rate).T,axis=0)
7    #captures the specific characteristics of sthaha music
8    mfccs = np.mean(librosa.feature.mfcc(y=X, sr=sample_rate, n_mfcc=13).T,axis=0)
9    #extracts the harmonic element
10    y_harmonic = np.mean(librosa.effects.harmonic(X, margin=3.0).T,axis=0)
11    return tempo,mfccs,y_harmonic

import csv
with open('total_features.csv', 'w') as fp:
    a = csv.writer(fp, delimiter=',')
    a.writerow(total_features)

1from sklearn.cluster import KMeans
2
3def extractFeatures(filename):
4    import numpy as np
5    features = []
6    features = np.array([features])
7    for line in file(filename):
8        row = line.split(',')
9        features = np.append(features, np.array(row[0:3]))
10    return np.array(features)
11
12 filename="/home/tharindra/PycharmProjects/WorkBench/MusicDataset"
13 features= extractFeatures(filename)
14 features=features.reshape(11000,3)
15
16 kmeans = KMeans(n_clusters=3)
17 kmeans.fit(features)
18
19 centroids = kmeans.cluster_centers_
20 labels = kmeans.labels_
21
22 for i in range(len(features)):
23     print("coordinate:",features[i], "label:", labels[i])

```

Figure 5: Clustering the features using K-Means

After the CSV file is created we would use a K -Means clustering to determine the labels of the dataset. For this we use the scikit-learn library which provides an easy implementation of this algorithm.

Then this dataset would be split into 3 portions as follows 70% as training ,15% as testing and 15% as validation. Finally the training data and testing feature vectors should be reshaped to be separately fed to the neural network during training and testing.

```

tr_features = tr_features.reshape(7700, 5)
ts_features = ts_features.reshape(3300, 5)

```

And also the labels should be converted in to one hot vectors because we cannot do comparisons with nominal values and also using one hot encoding facilitates ease of processing. Here we use an encoding which is an array of the length equal to the number of classes in our problem and we give an activation to the relevant position in the array depending on the value of the label. for example if the rating poor has a label of 0 this can be represented as a one hot vector as follows,

[1,0,0] where the position of zero is active to denote the label. When training and testing the neural network we provide it with the features and one-hot encodes instead of labels

```

1 def oneHot(labels):
2     import numpy as np
3     p = len(labels)
4     up = len(np.unique(labels))
5     b = np.zeros((p, up))
6     b[np.arange(p), labels] =
7     return b
8
9 tr_encode = oneHot(tr_labels)
10 ts_encode = oneHot(ts_labels)

```

Now since we have constructed our inputs in a suitable manner for feeding we have to now move on to development of the neural network.

2.Neural network design

The neural network has an input layer, 2 hidden layers and an output layer. The hyper parameters of the network are as follows,10 neurons in each hidden layer a learning rate of 0.003 and 600 training epochs.

```

1 # setting hyper parameters & other variables
2 training_epochs = 500
3 n_features = 3
4 n_classes = 3
5 n_neurons_ln_h1 = 10
6 n_neurons_ln_h2 = 10
7 learning_rate = 0.01

```

As we are using tensorflow for the construction of the neural network we use 2 placeholders which is a data type that allows us to feed data to the neural network during run time. These are very useful as we can sequentially feed each feature vector along with its corresponding one hot encode to these two separate placeholders.

```

1 # placeholder tensors built to store features(in X) and labels(in Y)
2 X = tf.placeholder(tf.float32, [None, n_features], name='features')
3 Y = tf.placeholder(tf.float32, [None, n_classes], name='labels')

```

when the input(feature vector) is fed to the first layer of the neural network its multiplied (using matrix multiplication )with the weight matrix which is of size [#features,#neuronsInHiddenLayer1] and provides the ability for each feature to be multiplied by each neuron .The values of the weight matrix are initialised with random values at the start of the training process. After we multiply the weight matrix with the feature vector we add biases to each output from the matrix multiplication.

The biases matrix is of size [#neuronsInHiddenLayer1], now this net input is sent through an activation function which will output a vector of size [#features] which will be the input to the next layer, the most popular activation function is Sigmoid and we have also used it because it gives an output within the range of 0&1. The next layer also operates in the same way and progresses to the output layer in which it goes through a Softmax activation function to produce a probability as an output.

```

1 # network parameters(weights and biases) a set and initialized(Layer1)
2 W1 = tf.Variable(tf.random_normal([n_features, n_neurons_in_h1]), name='weights1')
3 b1 = tf.Variable(tf.random_normal([n_neurons_in_h1]), name='biases1')
4 # activation function(sigmoid)
5 y1 = tf.nn.sigmoid((tf.matmul(x, W1) + b1), name='activationLayer1')
6
7 # network parameters(weights and biases) a set and initialized(Layer2)
8 W2 = tf.Variable(tf.random_normal([n_neurons_in_h1, n_neurons_in_h2]), name='weight')
9 b2 = tf.Variable(tf.random_normal([n_neurons_in_h2]), name='biases2')
10 # activation function(sigmoid)
11 y2 = tf.nn.sigmoid((tf.matmul(y1, W2) + b2), name='activationLayer2')
12
13 # output layer
14 W0 = tf.Variable(tf.random_normal([n_neurons_in_h2, n_classes]), name='weightsOut')
15 b0 = tf.Variable(tf.random_normal([n_classes]), name='biasesOut')
16 # activation function(softmax)
17 a = tf.nn.softmax((tf.matmul(y2, W0) + b0), name='activationOutputLayer')
    
```

Figure 10: Construction of the multi-layer neural

Now we define the cost function as cross entropy which is also a popular choice among cost functions.

```

1 cross_entropy = tf.reduce_mean(-tf.reduce_sum(Y * tf.log(a), reduction_indices=[1]), name='CostFunc')
    
```

$$H(p, q) = - \sum_x p(x) \log q(x)$$

Figure 12: Mathematical formula for cross

where q(x) is the predicted output and p(x) is the expected output. To convert this function into a minimisation function we put a minus in front.

And then we should optimise our cost function during the training process for this we use the Gradient Descent Optimization algorithm. It should be noted that during the training of the network over the 600 epochs we update the weight and biases after each input is fed to the network via a dictionary of feature values and labels. This updating is done by a fraction of the learning rate for this we use the optimization algorithm and we specify the cross entropy to be minimized. Thus allowing the network to converge to a particular function during the learning process.

```

1 train_step = tf.train.GradientDescentOptimizer(learning_rate).minimize(cross_entri
    
```

Then we also need calculate the accuracy so for that we need to know the number of correct predictions. So we

determine the correct predictions by comparing the actual label with the predicted label on the testing features by the network. Then we cast this boolean value to a float to determine the number of correct predictions as a value. then we display the accuracy as the number of correct predictions over the total number of test samples.

```

1 # compare predicted value from network with the expected value/target
2 correct_prediction = tf.equal(tf.argmax(a, 1), tf.argmax(Y, 1))
3 # accuracy determination
4 accuracy = tf.reduce_mean(tf.cast(correct_prediction, tf.float32), name="Accuracy")
    
```

### E. Evaluation

After developing the model we can use the model to make new predictions for that we need to save the desired model and restore it when we need to do prediction through it and the prediction can be made on a new record as follows

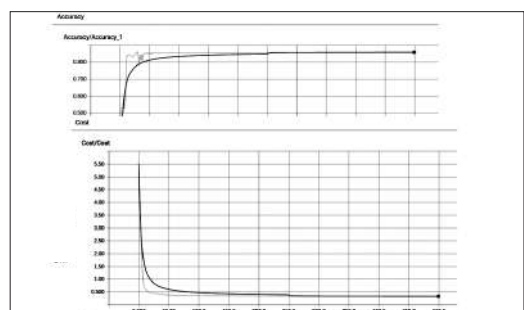
```

with tf.Session() as sess:
    sess.run(initial)
    saver = tf.train.Saver()
    saver.save(sess, "/home/tharindra/PycharmProjects/WorkBench/saveGeetha.ckpt")
    print("Model saved")
    saver.restore(sess, "/home/tharindra/PycharmProjects/WorkBench/saveGeetha.ckpt")
    print("Model restored")
    value = str(sess.run(((tf.argmax(a, 1), tf.argmax(Y, 1))), feed_dict={X:
    [[[-105.98996986418589,112.34714673913844,-3.1714756687506451e-07]], Y: [[1, 0, 0]]])
    
```

## III. RESULTS

### A. Performance Indices

the main performance indices we consider is the accuracy and the cost. We managed to achieve an accuracy of 50% and a smoothly decreasing curve. The following diagrams illustrate the above explanation. It should be also noted that the following results were obtained after a number of training runs by changing hyper parameters to find this temporary satisfiable solution.



Parameter Configuration	Performance/Accuracy
Training epochs :1000 Number of neurons in hidden layer one:1000 Number of neurons in hidden layer two:500 Learning rate:0.05	Accuracy:81%
Training epochs :1000 Number of neurons in hidden layer one:500 Number of neurons in hidden layer two:500 Learning rate:0.05	Accuracy:80%
Training epochs :500 Number of neurons in hidden layer one:60 Number of neurons in hidden layer two:60 Learning rate:0.05	Accuracy:85%
Training epochs :500 Number of neurons in hidden layer one:60 Number of neurons in hidden layer two:60 Learning rate:0.1	Accuracy:85%

Fig. 18: Changes in performance with respective

#### IV. SUMMARY & CONCLUSION

According to the extensive research I performed I observed that the currently there is no solution for the aforementioned problem in the context of Sinhala music. So we have not only built a solution for the system but we have optimized the solution and the code in various ways such as using clustering in determining the labels, and using prestored data for feeding input.

#### ACKNOWLEDGEMENT

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# RESEARCH DIRECTIONS FOR NETWORK BASED VIDEO STREAMING WITH EMPHASIS FOR LIVE SCREEN MIRRORING

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**Abstract** - Recent advancements in the field of embedded systems and network speeds in general – particularly the realization of concepts of image processing, live video streaming and Internet of Things have redefined the technology world, as we knew years ago. In terms of video streaming, the rapid increase of speeds of networks around the world have enabled fast and efficient streaming of live content. Embedded systems have made it simpler to build portable devices which can stream live video via a network. This review analyses these developments in detail, outlining the potential left for development. In doing so, the paper looks at techniques and technologies that have been used for streaming videos over networks. Special emphasis is placed on using the available technologies for screen mirroring and live video broadcasting. Development in these concerns will assist in developing lightweight wireless systems for TV stations to personal video uploading in social media.

**Keywords** - wireless video transmission, embedded systems, screen mirroring, live collaboration tools

## I. INTRODUCTION

Video transmission over networks has been a contended topic of research ever since the birth of the Internet. Though many technologies have developed over time, one significant shortcoming which marred the propagation and the popularisation of network video streaming is the practical issue of low bandwidth in networks. In the current sphere, however, most countries have achieved significant

network bandwidths with the development of ADSL, 3G and 4G networks around their countries. In such a context, live video streaming has become a crucial area of research as it now involves the added concern of managing millions of connected devices at once. It is predicted that there will be over 25 billion connected devices by the year 2020 (“The Evolution of Mobile Technologies,” 2014).

As of 2017, major corporations are focussing strongly on live video streaming. As such, “streaming” is moving into the mainstream. This focus has resulted in apps like Periscope (“Periscope - Live Video - Android Apps on Google Play,” 2017), YouTube and Facebook Live which have made it easy for anyone with a smartphone to start streaming. They have normalized the idea of live streaming video and as a result millions of people are now used to this type of content. That growing ubiquity represents an opportunity for other businesses. Live video can be a powerful tool for marketing, sales, training, entertainment, or media, as it is a compelling technology for everyone, in effectively transmitting a message of pages in a few seconds (“Youtube Live vs Facebook Live compared to Online Video Platforms,” 2017).

Though this is the status quo, the birth of all these technologies run years behind. This paper thus discusses the development of wireless (online) video streaming technologies and engages in a comparative analysis of the same.

Another important aspect discussed in this paper is the parallel development of live collaboration software tools.

These tools have been the artefacts to show how much technology has triumphed in its application. Online collaboration tools have become instrumental in many areas including business and education.

Though technology has developed at an alarming rate, one underlying factor of limitation when it comes to streaming live video is the bandwidth problem. To overcome this, either smaller packets of data containing the video data should be transmitted or more effective algorithms must be used. These however should be done in such a way to ensure that the quality of the video is not diminished.

This paper therefore looks at the above-mentioned aspects and how these technologies can be integrated to deliver higher quality streaming experiences to the end user. The essential hypothesis is to see if such integration is possible within technologies available as of today and to assess potential issues associated with the same. The objective of this research is therefore, to identify the applicability of network based video streaming for live screen mirroring. In general, the paper analyses related aspects, as mentioned above, in detail.

The paper is divided into 3 main sections – literature review – which highlights the research and the journey thus far in above technologies, discussion – analysis of the contents of the literature review, and finally the conclusion – concluding remarks as to what developments may be undertaken by future researchers.

## II. LITERATURE REVIEW

### A. Video Transmission Techniques

Firstly, literature clearly shows that there has been a constant interest to research about the various video transmission techniques which can be deployed for network based video transmission. Networks function in layers in which a data packet goes through a stack of different layers which perform distinct functions to the data packet. These layers include both hardware and software. Therefore, it could be seen that optimisation for video transmission could be achieved at both a hardware level and at a software level. One of the first approaches is seen in (Cherkassky et al., 2002), where the project focuses on the issues in wireless transmission of image and video data – video compression and network prioritization which are the key factors to consider when making efficient use of the limited bandwidth. In (Shan, 2005), a network layer-based video transmission technique is discussed

which uses equal-sized radio link protocol (RLP) packets. Quite an extensive analysis and a mechanism into “optimizing” video streaming for wireless transmission is discussed in (Lu, 2009), where a method described as “PROTAR” has been used. This again is a layer-based approach. A packet scheduling algorithm for wireless video streaming has been discussed in (Kang and Zakhor, 2002), which is based on unequal deadline thresholding. First, the proposed video packet scheduling algorithm is efficient in achieving unequal loss rate between video packets with different importance. Second, the motion-texture discrimination is more efficient for large motion clips and small quantization step, i.e., large size of texture fields. Though a key assumption in developing this algorithm has been fixed round trip time, it is a safe assumption to make in today’s context of high speed networks. Wireless network modes are analysed in depth in (Ketkar et al., n.d.), where they claim that WiMAX could be more efficient to transmit videos over networks as opposed to Wi-Fi and ADSL. A voice and video over Wireless LAN technique is discussed in (Iyer et al., 2013) and the results show how a WLAN is in fact more efficient than using a LAN for intra-organization communication of video and voice. In (Ramya et al., 2015), a system has been devised to act as a framework to stream cloud based video streams to a “CCMN” – Cloud-Centric Media Network. This is capable of a multi-screen application but what it does it telecasting “one screen” to many other screens and not vice versa.

Another popular protocol proposed for video transmission is Transmission Control Protocol. TCP is widely used by commercial video streaming systems. When a packet has not arrived by its playback time, a typical practice in these commercial systems is that the client simply “stops and waits” for this packet, and then resumes playback. This stop-and-wait playout strategy is easy to implement. However, stopping playout due to late packet arrivals renders the viewing experience unsatisfactory. A continuous playout strategy, i.e., continuing playout regardless of late packet arrivals, also leads to unsatisfactory viewing experience, since late packet arrivals cause glitches in the playback. The performance of both the stop-and-wait and the continuous playout strategies therefore depends on the frequency of late packet arrivals during the playback of the video. In (Wang et al., 2003), where a model is proposed to overcome these issues, discrete-time Markov models have been developed to evaluate the performance of live and stored video streaming using TCP. Based on these models, guidelines have been provided as to “when” using TCP

for streaming leads to satisfactory performance. A crucial finding in this research has thus been that the fraction of late packets is similar for long videos in constrained streaming while it decreases with the video length (after a short duration of increasing trend at the beginning of the playback) in unconstrained streaming.

A more recent development has been the RTS (Real Time Streaming) Protocol. The RTSP protocol is based on the HTTP protocol, and is commonly used to manage media content streaming. This protocol doesn't directly deal with the streaming content, but uses the RTP protocol to handle content transmissions. (Peltotalo et al., 2010) discusses a peer-to-peer streaming application using this protocol. The effective real-time P2P streaming system for the mobile environment presented in this paper is an alternative solution to traditional client-server-based streaming applications. However, it also highlights that more advanced laboratory tests with different latencies and throughputs between peers are still needed to highlight system bottlenecks and usability issues.

RTMP (Real-Time Messaging Protocol) is also a widely-used protocol nowadays for live video transmission. RTMP is the Adobe's network protocol used to transmit audio, video and data between its Flash platforms (Adobe Incorporated, 2011). RTMP consists of two important structures, namely Message and Chunk. RTMP belongs to the application-level protocol, and usually TCP is accompanied with it as the transport-level protocol. The basic unit of the RTMP transmitting information is the "Message". During transmission, for consideration of multiplexing and packetizing multimedia streams, each Message will be split into some "Chunks" (Lei et al., 2012).

Another example of P2P (Peer to Peer) streaming is seen in (Tran et al., 2003), where first, an end-to-end transport architecture for multimedia streaming over the Internet is presented. Second, a new multimedia streaming TCP-friendly protocol (MSTFP), which combines forward estimation of network conditions with information feedback control to optimally track the network conditions, is discussed. As the said protocol is TCP based, it would still have the inherent issues which TCP communication has always had.

In (Seeling et al., 2004), a discussion is available on how to evaluate the network performance for single-layer and two-layer encoded video using "traces". As (Zhu and Girod, 2007) notes, in network video transmission, cross-layer information exchange is required, so that

video source rates can adapt to the time-varying wireless link capacities. They note that many problems remain, particularly in the context of wireless mesh networks – for instance, it is still unclear whether the stringent latency constraint (usually less than a second) for video streaming can be met when packets need to be delivered over multiple hops of time-varying wireless links in a mesh network. Typically, the wireless network is shared by both video streaming and other applications such as file downloading. The problem remains to be addressed as how to optimally allocate network resources among heterogeneous traffic types, each bearing a different performance metric (e.g., completion time for file downloading versus video quality for streaming). For example, in a case of where a wireless projecting device is connected to a machine, there is a possibility that the network being used to be used for various other purposes too (Zhang et al., 2001), while broadcasting the screen to the projector. Such a situation can surely limit the bandwidth required to broadcast the screen at a higher frame rate of more than 25-30 fps. Even more problematic is the situation where "many" clients would be trying to connect to the projector for multi-screen sharing. This problem presents a totally new research problem of not only having to stream the videos fast, but also having to combine them in an effective manner. Back in 2001, as per (McCrohon et al., 2001), it was predicted that it would be possible to stream live lectures, "with expected future developments in networking technology, the quality of streamed video will soon be of even higher quality ensuring video streaming a promising role in the delivery of online education." However, even with technologies available 15 odd years later, it is still doubtful if a "real-time" output can be achieved – to transmit the video feeds of many device and combine them in one device.

Dynamic Adaptive Streaming over HTTP (DASH) (also known as MPEG-DASH) is quite a modern technology which is now used for high quality streaming of media content over the Internet delivered from conventional HTTP web servers. Like Apple's HTTP Live Streaming (HLS) solution, MPEG-DASH works by breaking the content into a sequence of small HTTP-based file segments, each segment containing a short interval of playback time of content that is potentially many hours in duration, such as a movie or the live broadcast of a sports event. This is probably the best solution that is available for live streaming of content at the moment. The MPEG DASH standard was published by the ISO in April 2012 (Andy Salo, 2012).

A comparative evaluation of most of these techniques is seen in (Aloman et al., 2015). They have conducted a comparative performance evaluation of MPEG DASH, RTSP, and RTMP streaming protocols over 4G and Wi-Fi (IEEE 802.11g/n) real networks in terms of QoE (Quality of Experience), tested both video on demand and live video streaming. Results in this analysis has suggested that RTSP is more efficient than MPEG DASH for starting the video playback, but at the expense of decreasing QoE due to packet losses. In addition, the long pre-loading time interval needed by MPEG DASH or RTMP permits to alleviate the impact of the packet losses which take place during the transmission, as revealed by a lower number of re-buffering events for these two protocols. MPEG-DASH surely the best available protocol currently, for streaming content such as TV series and / or live events. This is for requirements that demand both high quality and speed at the same time. However, this obviously requires a network with high bandwidth. Therefore, for other lesser needs, specifically for purposes of screen mirroring and such, RTMP is a lucrative option.

**B. IoT Based Embedded Systems for Video Transmission**

Secondly, we should look at the developments of the IoT sphere as well. Transmitting video over the web using embedded devices has surely been an area of crucial significance for the development of the IoT ecosystem. Most of the integrations among various technologies have been possible due to the rapid accession and research on development boards such as Raspberry Pi and Arduino.

A classic integration of embedded systems with IoT and image processing is seen in (Kulkarni et al., 2014). Here a surveillance robot has been developed which is capable to transmit a video stream over the web. To be able to do this on a simple chipset such as Arduino, clearly shows that complex systems could now be implemented using available technologies. Image processing has also become more viable on a Pi as it contains both a Graphics Processing Unit (GPU) along with an internal memory. This aspect has been explored in (Ujjainiya and Chakravarthi, 2006), where the system is used to detect the objects in front of a vehicle by using a camera module. The camera detects the picture and operation is performed in OpenCV to detect the edges of the detected picture. Another image processing example is seen in (Manasa et al., 2015), where the paper proposes the design and implementation of object counting algorithm based on image processing by

using the RPi on real time basis. RPis are also ideal for the construction of surveillance systems both in-house and remote. This is explored in (Chumurkar and Bagdi, 2016), where a video stream is transmitted via the web to a mobile device.

A recent device which professes IoT capabilities is the Intel® Compute Stick shown in Figure 1 (Pete Carey, 2015), which came to the market as late as 2016. This is a complete computer in a “stick” with a HDMI port. This too, would be ideal for streaming video via a wireless method, but the only drawback of this device is that it is quite costly compared to the RPi. Research done using this device is yet to be seen and as thus, the reliability and performance is yet to be assessed.



Figure 1: Intel Compute Stick features

**C. Screen Mirroring / Projection**

Nowadays, screen mirroring devices (McGill et al., 2014) have been built by integrating the wireless video transmission techniques discussed above and using various chipsets. There is also a possibility where projectors will soon become completely wireless, minimizing the many practical restrictions (not being able to project more than one screen, issues setting up wire cords etc.) that traditional projectors undergo. Therefore, a review of these available devices is apt.

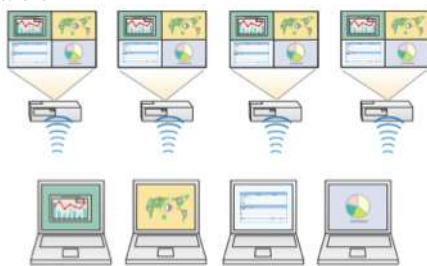
We now look at existing projectors out in the market. The existing projectors provide the basic functionality of where one wired device can be projected. In the last 3-4 years, many projectors, however, have been developed with the capabilities of WLAN (BenQ, n.d.) (Epson, n.d.), meaning the projector can connect to a client using a wireless mode.



A few of these are in fact capable of screen sharing like most of the Epson® PowerLite versions using the Epson iProjection™ App (Epson, 2015). These algorithms and implementations are proprietary and allow for a limited scope of application.

Apart from these commercial products, there is little literature available on projects conducted at an academic level relating to projectors itself. This is probably due to the nature of the projectors being predominantly a commercial device. However, a couple of research projects is to be noted. In (Chheda et al., 2013), a Raspberry Pi has been used to transmit the video feed from a desktop to the Pi. The mode of transmission is Wi-Fi and this could be identified as a basic implementation of media streaming over a network. No “enhancing” procedure is available in transmitting the frames and this project depicts and predicts (in further research), how the same concept could be used to create an adapter-like device for already available projectors.

When considering the technical aspect, it could be seen that there are many projectors available in the market deploying one or more of the above technologies intended to achieve real-time wireless video transmission. However, most of the companies who have involved themselves in developing projectors of this sort have provided a profound description of the technicalities of the same. Leading projector brands such as BenQ (BenQ, n.d.), Optoma (Optoma, n.d.), Epson (Epson, n.d.), Panasonic (Panasonic, n.d.) and Acer (Katie Scott, 2008) seem to have built wireless projectors as of late. A few of the models offered by these brands have the “multi-screen” split feature (Shown in Figure 2). Many include an app for mobile devices (Android and iOS), and come equipped with proprietary algorithms. The NEC MultiPresenter Stick (NEC, 2016) is a 2016 device with quite sophisticated features but it still requires a NEC compatible projector to work with.



**Figure 2: Application of screen-split option in a wireless projector**

However, as it may be, there has not yet been a model capable of connecting to the internet to pull a feed from a device not located in the current location. Furthermore, almost all these models use proprietary software meaning they are only compatible with the set list of devices produced by the manufacturer. Also, there is no way that a customer with a projector with no wireless capabilities can enjoy these features unless s/he buys a new projector.

**D. Online Collaboration Tools**

Next is to consider commercial software solutions which address the need of online collaboration. Many tools are available such as GoToMeeting (“GoToMeeting,” n.d.), Skype for Business (Skype, n.d.), Join.me (Join.me, n.d.), screenleap.com (screenleap, n.d.) and so forth. A few of these provide multi-user interaction while some provide interfaces for customized viewing such as manipulating PDF files, presentation slides etc. All these solutions, however, limit their usability and reliability on the availability of their proprietary systems. A summary of these systems is seen in Figure 3:

Software Platform	Multi user	Dependant on a web platform?	Image optimisation techniques
Skype for Business	Yes	Yes	No
Join.me	No	Yes	No
Screenleap.com	No	Yes	No
TeamViewer	Yes	Yes	No

**Figure 3: Comparison of software solutions for screen sharing**

**E. Pre-processing Before Streaming**

Is it also important to look at research that has gone into pre-processing image frames before being streamed via a network. This means that the streams received by whatever device (from clients) will undergo a stage of pre-processing to “enhance” the frames received. This may vary from changing basic properties such as contrast, brightness, mid-tones and so forth. This could be achieved via existing graphic processing libraries such as OpenCV (open source - (“OpenCV library,” n.d.)) and CUDA (proprietary - (“CUDA Zone,” 2015)). Both libraries are quite powerful in their own ways.

(Di Salvo and Pino, 2011) has highlighted how applications have been parallelized in various areas using CUDA, to achieve very high-performance in time processing keeping the same performance in terms of accuracy. They further note that the main portion of the available CUDA based approaches deal with the parallelization of generic image processing operations, whereas much more work should be done in the biomedical and video-surveillance fields, where this is mostly used. OpenCV on the other hand is more prominently used for “detection purposes” in videos. This is shown in many research literature including (Pulli et al., 2012), (Shah, 2014) and (Farhadi-Niaki and Mehrvar, n.d.).

### III. DISCUSSION

The methodology of this research centres around the performance measures of different video transmission techniques and how each performs for the purpose of live screen mirroring. Such factors include transmission speed, reliability, quality of decoding, platform dependability, scalability and usage of image optimisation techniques.

Firstly, when referring to the status quo of video transmission protocols MPEG-DASH and RTMP seem to be two protocols which are in the forefront when it comes to real-time video transmission.

Another concern is “how” the video frames should be transmitted. Should they be transmitted as “frame by frame” or should it be after a pre-compression technique has been applied such as after converting the stream to a format like “mp4”? What are the already available packages which can do this? “FFmpeg” (“FFmpeg,” 2017) is one such strong open source library available for streaming audio / video which supports both above techniques (Wan and Dai, 2016). This easily supports Linux based systems and thus runs fine on embedded chipsets discussed here. Furthermore, this library also supports mobile platforms such as Android. In (Fu et al., 2010) an Android-based codec application is designed and implemented using Java with FFmpeg. Therefore, this would be an ideal solution for anyone planning to implement a video transmission algorithm.

Secondly, what is a possible embedded system which can be optimized for video transmission? In comparison, Arduino has limited support for video streaming. ComputeStick is surely a high-end option which supports video streaming but when looking at other concerns such

as the cost and cross platform capabilities, the ideal chipset for mini scale projects, specifically for screen mirroring concerns would be the Raspberry Pi. Another similar concern is what methodology is most appropriate for network connectivity. For this, the most intuitive solution would be to use the technology which offers the “fastest” bandwidth. However, it should be noted that video transmission does not solely depend on the speed of the network, but rather on concerns of priority accorded to video packets. WiMAX + LTE technologies warrant the most optimized connectivity (Iyer et al., 2013) for video streaming.

Thirdly, when looking at the aspect of screen mirroring, as discussed, most projectors are now becoming wireless. It is a matter of time for all our devices to come void of HDMI / VGA ports. More academic research should be undertaken in this area, though, to ensure that the most optimized methods of screen mirroring maybe identified and studies done, as opposed to comparing commercial solutions, due to the restrictions posed via proprietary algorithms. Further research should look at extending its functionality to intelligently analyse the video streams received and provide some basic image corrections (Sukthankar and Mullin, 2000) before it is broadcast.

### IV. CONCLUSION

This paper discussed, at length, the various advancements in the fields of wireless video transmission techniques, IoT and embedded systems which can facilitate such techniques, screen mirroring techniques and various pre-processing that can be done to livestreams using image processing algorithms. Though one may claim these are distinct research areas, that is not the case in reality. Many real-world applications are being modelled using these aspects. The development of chipsets has now allowed a massive level of data manipulation, graphics data processing and storage abilities. It is important that these chipsets are used to achieve their true potential by researchers and it could be said that much has been already done. However as mentioned, there is room for improvement in integrating all these technologies to build useful embedded systems for day-today use. Such research need to be undertaken with the constant thought in mind that the limitation of network bandwidth should not hinder the performance and speed of the streams being broadcast over a network.

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# A REVIEW ON HOME AUTOMATION WITH HUMAN BEHAVIOUR

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**Abstract** - Smart homes have been viewed with increasing interest by both home owners and the research community in the past few years. One reason for this development is by using modern automation technology such as Arduino in the home or building, it promises considerable savings of energy. Therefore simultaneously reducing the operational costs of the building over its whole lifecycle. At present one of major issue in Sri Lankan society is high electricity consumption. As a solution for that we are proposing a system which identifies human behaviour to make decisions mainly for lighting. The integration of these everyday systems will give the average homeowner the control they desire within their home easily. This work highlights various current systems with their pros and cons and how to prevent those weaknesses.

**Keywords** - smart home, automation, arduino

## I. INTRODUCTION

The concept called “home automation” has been there since the late 1970s. (Cyril Jose and Malekian, 2015) But with the advancement of technology in both software and hardware fields, people’s expectations of how an automation should work or the way that the services should be provided has changed a lot during the course of time. So idea of “home automation systems” were improved day by day. This work highlights various flaws in existing home automation systems. In this paper, it has addressed what is Home automation and how it works under various technologies with advantages and disadvantages of them. After that the

challenges in home automation systems from the point of view of both the homeowner and a commercial user. This work goes on to explain why home automation systems are such attractive targets for an attacker and how the various technologies handle it.

Under the first topic it has mainly considered about a brief introduction about this review paper and what is the content of the whole paper. Under the second topic “technical review” it presents a brief explanation about various home automation systems that exist and some concepts that are planning to build. It also mention about the technologies which were used to make these kind systems much more efficient and user friendly to the user. In “technological review” the main target was to address the technologies that were used while the researches completing their projects such as neural networks, programming boards etc... The work concludes by explaining future directions home automation System Research could take in much more efficient and cost effective way.

## II. SYSTEM REVIEW

Under this topic it has been described about the existing home automation systems and the systems which are still in development stage or which are still concepts. If we look at various home automation systems over the course of time, developers have always tried to provide efficient, convenient, and safe ways for home inhabitants to access their homes. Irrespective of the change in user

expectations, advancement of technology, or change of time, the role of a home automation system has remained the same. (Cyril Jose and Malekian, 2015) Each and every system uses various kinds of technologies to implement there system and there are advantages and disadvantages of using those.

The paper called "Home Automation Systems - A Study" (Palaniappan et al., 2015) by S. Palaniappan, N. Hariharan, N. T. Kesh, S. Vidhyalakshimi briefly describe about some home automation systems. Based on all the systems surveyed with their pros and cons, this paper presents the features to be added to an ideal system for home automation with remote access. In this paper it shows comparison between systems such as Bluetooth, GSM, mobile based, Zigbee and Wi-Fi. The systems that have been considered by the researches have mentioned about certain common features. All of them are based under a same principle which is those kind of systems use a basic underlying communications technology. The pros and cons of the system originate according to the underlying technology. All of those systems have a controlled electrical structure which is used to connect with the electrical peripherals. They have mentioned about a common command system that will be used to issue commands to the control circuits. A major part in the system is done by the user interface. This decides how the user will interact with the system and extent of control the user applies while them using the system. This effects the usability and the user friendliness of the system. Most systems have security features as well. It has added to ensure only authorized access to avoid unauthorized accessing and unauthorized updating of current data to protect confidentiality and integrity of the system. To prevent that most of the systems use various kinds of security mechanisms. At the same time these kind of system should be available from all over the world to a user and in real time. These are the main points that the research considered from the overall study.

There's another paper which was concerned about above technologies. That paper is "An overview of home automation systems" (Asadullah and Raza, 2016) by M. Asadullah and A. Raza. In this paper different home automation systems were surveyed with their strengths and weaknesses. as an example Bluetooth based system is a flexible and low cost medium, but that kind of system is limited to a short range of Bluetooth wireless network. System which are controlled by the voice recognition are most suitable for elderly and handicapped people, because they can control them by saying the name of appliances

or by using a specific key word. Such systems are noise sensitive and the problem is accuracy can be affected by signal to noise ratio (SNR). So this kind of system is not suitable for a noisy place. Another automation mechanism used is ZigBee RF modules for the implementation of wireless network. Inside these kind of wireless networks the user has the full remote controlled access of home appliances. In this paper a GSM based module is also studied and according to this system user can control and monitor the home appliances via text message from his or her mobile phone. But these kind of systems are much more slowly compared to other systems. Internet of things based home automation system can only work in the presence of internet. The rapid growth of IOT devices brings concerns and benefits. The future of home automation system requires to make homes smarter and more convenient to make things easier to the user. As for the future work it is suggested to develop image processing based home automation system using the technologies which discussed above. In such kind of automation system, home appliances will be controlled by different gestures which will be identified through the camera. Moreover, home automation system could be developed by using technologies such as interfacing biomedical signals (Electromyography (EMG) signal) with computer, it will offer opportunity to amputee to control appliances from different arm gestures. It will be useful in area of robotics for controlling robot through gesture for different tasks. In addition, future work would be implementation of above discussed home automation systems on a much more large scale, such as factories, industries, offices etc.

So if we take those technologies individually, first we can concern about the Bluetooth technology. The paper called "Bluetooth Based Home Automation and Security System Using ARM9" (Naresh et al., 2013, p. 9) by D. Naresh, B. Chakradhar, and S. Krishnaveni, has clearly stated about how that research used Bluetooth technology to fulfil the need of home automation. This paper put forwards the design of home automation and security system using ARM7 LPC2148 board. Home appliances are directly connected to the board and communication is established between the board and ARM9 using a Bluetooth device. According to the paper, that low cost system was designed to improve the standard living in home. Its remotely controlled by ARM9 provides help and assistance especially to disabled and elderly. In order to provide safety protection to the user, all the electrical switches were replaced by the low voltage activating switches. Moreover implementation of wireless Bluetooth

connection in control board allows the system installation in more simple way. The control board was directly installed beside the electrical switches. So the switching connection was controlled by relay. Furthermore, flexible types of connections were designed as backup connections to the system in a case of emergency. The connected GUIs are fully synchronized with the ARM board. They show the real-time switches status to the user. The system is designed in a very much user-friendly way with a good interface. As for the future work, they were planning to implement the speech recognition in order to control via voice control. In that current system all the voice signal inputs to the ARM9 were transmitted to the Window GUI for signal processing. These are the key features which were mentioned on that paper. Due to the use of Bluetooth, the weakness of that system was the range of the system was concluded into a small area.

There was a paper called “Smart GSM based Home Automation System” (Teymourzadeh et al., 2013) by R. Teymourzadeh, SalahAddin Ahmed, Kok Wai Chan, and Mok Vee Hoong, mainly concerning about the GSM based system. This research work investigates the potential of “Full Home Control”, which is the aim of the Home Automation Systems in near future. The study and implementation of the home automation technology using GSM used a modem to control home appliances such as light, air conditional system, and security system via SMS. The proposed system was mainly focused on the functionality of the GSM protocol, which allows the user to control the target system away from residential, using the frequency bandwidths. For the development of the smart GSM-based home automation system they have used the concept of serial communication and AT-commands. So home owners will be able to get a feedback status of each and every home appliances under control whether it is switched on or off remotely from their phones. So simply the mobile phone acts as the remote in this system. That proposed prototype was implemented and tested by the researchers with maximum of four loads and shows the accuracy of more than 98%. Finally with that kind of big accuracy this system would have been an effective system.

Another research was concerned with the use of GSM technology for their system. That was “Microcontroller Based Home Security System with GSM Technology,” (Hasan et al., 2015) by R. Hasan, M. M. Khan, A. Ashek, and I. J. Rumpa. In this paper, design and implement of a microcontroller based home security system with GSM technology have been presented and analysed. Mainly

with two microcontrollers and other devices such as LED, LCD display, Buzzer and GSM Module are used for reliable operation of the proposed system. They added some ways to input to the system. First way is that the mobile phone is interfaced with microcontroller through a Bluetooth device in order to control the system. Then, a manual keypad is another way to lock or unlock the system. A Compiler Code “Vision AVR” is used to design a program that controls the system along with maintaining all functions such as controlling and security. That paper presented design and implementation of a smart home security system based on microcontroller along with GSM for user friendly application. That system was intelligent enough to monitor environment. At the same time, the user is informed about each and every security breach using GSM network that provides a special opportunity whenever the user stays at far away from home. However, Android application was the most spectacular feature in order to control the system through a Bluetooth device. The system has provided the reliable operation within reasonable cost and removes the system complexity. In this work, traditional burglar alarm mode, LED lights and LCD are the promising features used to ensure reliability. The whole system was developed on a practical home security system which requires significant effort to install it. The system is also appropriate for commercial purposes because of versatile ways of security, confidentiality and controllability. At the latter part of that paper it concluded with test results of practical circuit which show the proper functionality and also validate the reliable security compared with its reasonable cost.

Few researches concerned about using Wi-Fi technology for their system. One of them is “Design and implementation of a WIFI based home automation system,” (ElShafee and Hamed, 2012) by A. ElShafee and K. A. Hamed. That paper basically concerned about the design and prototype implementation of new home automation system by using WiFi technology as a network infrastructure connecting its main parts. That proposed system consists of two main components such as the server and the hardware interface module. That paper proposed a low cost, safe, universally accessible, auto-configurable, remotely controlled solution with many more functions. The main approach stated in the paper has accomplished the target to remotely control home appliances by using the Wi-Fi as the medium to connect system parts. Wi-Fi technology capable solution has proved to be controlled remotely, provide home security and is cost-effective by comparing to the previous systems. In that paper the system design and the main

architecture used were discussed briefly, and prototype presented the basic level of home application control then the remote monitoring was implemented according to the design. Finally, the proposed system was better from the scalability in the point of view by comparing to the previous automation systems. Unlike most of available automation system in the market, that system was scalable because by using one server can manage many hardware interface components as long as it is in the range of that WiFi network coverage.

Another research mentioned about the wireless method “Zigbee” as their technology. That paper was “Wireless home automation system using zigbee,” (Arul, 2014) by S. B. Arul. This paper contained the overall design of a wireless home automation system that was constructed and implemented. Main concept of that project on recognition of voice commands and uses low-power RF ZigBee wireless communication components which are quite cheap than other technologies. The home automation system was proposed to control all lights and electrical applications in an ordinary home or office using voice commands. The system was tested and confirmed. The main verification tests included voice recognition response test which was known as the “indoor ZigBee communication test”. That test involved sending a total of 70 basic commands and the rate of efficiency was 80.05%. Main target of that system was elderly and disabled people. This research had worked to achieve main four key features which are

- Low Power
- Interoperability
- Mesh Networking
- Robust

The system implements voice recognition unit using HM 2007. That system implemented the wireless network using ZigBee modules for their efficiency and low power usage. So the end test results were promising in that project because of those reasons.

There was a research called “Intelligent Home Automation System using BitVoicer,” (Krishna and Lavanya, 2017) by I. Krishna and K. Lavanya which is also concerned about technology in Zigbee. In most of developed countries, many households have home automation systems which notice their environment and act on the data to trigger home devices. But these systems are not very popular in developing nations with compared to developed nations due to their high pricing. Also, almost all of these kind of systems are hard coded so they just giving decisions

based on the iterative conditions it recorded. The proposed Zigbee based automation system and Wi-Fi network are combined through a mutual home gateway. That combination simply offers network interoperability, a simple and a user friendly interface, and remote access to the system. That proposed system was very useful for elderly and physically disabled persons who mainly needed the physical assistance for daily requirements. It removes the limitation of wiring difficulties and also the range of voice commands can be increased by using wireless routers and internet of things. On the off chance the practical usefulness and the cost of that automation decrease will enable compatibility with future technologies for improved user support. It mainly stated that creation capacity as well as innovation level of the system was going to enhance increasingly. In Future, by using a technology like Arduino, it can enable the control via central server through smart mobile phones.

Another related system which was created “Self-configuring home automation networks based on psychophysical principles,” (Flessner and Frenken, 2016) by is J. Flessner and M. Frenken. That paper says that the apparent comfort of building environment may be improved by the development of the interaction between users and home automation control. A higher level of interaction is possibly achievable by including the psychophysical condition of the users. A methodical way for the design of an adaptive automation system was presented. A fundamental part of this method was the comparison between current guiding principle and discoveries about the effect of environmental factors on the user’s mental and physical condition. The main application of this method was basic principle for the design of building controls. According to the researcher it could lead to the creation of healing environments. To respond dynamically on changes of the user’s condition, a rule base system had to be developed to create a self-configuring automation system. As the future works, the implementation of the idea for a selected subset such as ventilation, heating or lighting had to be done to review the feasibility of the proposed system. For that purpose, the interface between user and automation control need to be designed. One opportunity is the use of identification mechanisms to dynamically react according to different people inside the building environment. At the same time according to the identification of the users, an adaptive home automation system needs to respect different people with various requirements. Therefore the process to handle changing or oppositional requirements is required according to the opinion of the specific researcher.



According to the current systems and current technologies which are mentioned above, it can be concluded to a single table for the features of each and every system under the system review.

**Table 1. Current Systems**

System	Primary Communication	Remote access	Number of Devices	Cost	Speed	Real Time
GSM	SMS messages	Access from anywhere in the world	Unlimited	High cost due to SMS charges	Slow due to delivery issues	No
Bluetooth	Bluetooth and AT commands	Restricted to Bluetooth range- 10m	Unlimited	Fast due to proximity	Fast due to proximity	Yes
Phone Based	Phone lines	Anywhere with a phone line	12 due to 12 frequencies of DTMF	Fast	Fast	No
Zigbee	Zigbee and AT commands	Around 10m	Unlimited	Fast	Fast	Yes
Wireless	Radio, infrared or other waves	Depending on range and spectrum of waves used	Unlimited	High cost due to licensing and other spectrum issues	Slow due to Interferences	Yes

### III. TECHNOLOGY REVIEW

Under the sub section of technology review it has mainly considered about some papers which are deeply discussed about some technologies related to the proposed system. The first paper is “A tool for the analysis of energy systems in Smart Cities,”(Fabbri et al., 2016) by G. Fabbri, C. M. Medaglia, D. Sbordone, and B. Di Pietra. This paper mainly considered about the analysing energy usage and identifying the patterns within those records. Cities represent three quarters of world energy usage and 80% of CO2 emissions globally being the most dangerous of any environmental policy challenge. To deal with this continuous urban growth there should be new methods to manage cities and make them more efficient in order to prevent those kind of problems. The union between the world of energy and the field of information technology, will pave the way for a new bionetwork of services which should enable both reduction of energy consumption and improve the better quality of life. Due to the massive development in the field of IT, it is converting all economic sectors, including energy to an optimized way than the past. In this paper the main issues related to smart grids and their integration with the cities will be analysed emphasizing the significance to set of simulation tools and models aimed at facilitating feasibility analysis for smarter energy technologies.(Fabbri et al., 2016) according to that paper a simplified tool was under development to introduce to the micro grid and distributed power systems projects. The tool takes in account both conventional and renewable technologies for energy and that was designed to simulate as a micro grids or as a distributed

generation within a larger grid. According to that paper the first results from that tool had been compared with experimental results and by using these kind of data from previous tests and used to perform simulations of various systems.

There’s a paper which mainly considered about how to identify the human behaviour for such kind of a system. The paper is “(Ebeid et al., 2016),” by E. Ebeid, R. Heick, and R. H. Jacobsen. A framework for deducing user behaviour from smart meter data has been presented in that paper. According to the researcher the framework separates the disaggregation analyses from the natural language data processing. It uses uniform interfaces to exchange data seamlessly between its items. It relies on a shared database which enables easy upgrades of the framework components. Experiments have been performed and the results have been evaluated for choosing the data reconstruction and Load Disaggregation Algorithm (LDA) algorithms. The experiments have shown the complete framework’s data flow process starting from aggregating the main meter data and ending by delivering natural language reports. The experiments have validated the feasibility of the framework. Future work will include analysis of multiple users ‘ behaviour. Different smart meter data will be utilized for improving the detection accuracy of the LDA algorithms. At the same time the researcher also concerned about the privacy of the user as well.

The paper called “Home automation system with android application,” (Azni et al., 2016) by M. N. Azni et al is mainly considered about how to use android to create such a system. This work demonstrates a simple home automation system that permits the consumer to control home applications via wireless medium such as Wi-Fi using an android application. Electronic peripherals such as Lights, A/C, electronic doors and fans could be used in that proposed system. In this system, the controlling and monitoring the appliances can accomplish by using mobile based on Android application. The web interface had framework known as Restful Api and function as to control Raspberry Pi gpio using an http request. Besides that, Android apps will exploit the services provided by Restful Api for controlling gpio of Raspberry Pi. Both the methods are using Restful Api but it is included in the web interface, whereas for Android we need to add their suitable functionalities. The server software was run in a desktop PC. Raspberry Pi board was used as the main board to connect the appliances thru input

ports and output ports. The communication between the smartphone and the Raspberry Pi board is based on a wireless network such as WiFi. As the conclusion, that system could be defined as useful application to everyone and especially for disabled and elderly people. This system also had been developed with a user friendly Interface to allow more users will able to implement the system in a much cheaper way. According to the researcher's point of view that project also can be developed by adding support to iPhone (iOS) and Windows Mobile user because smart phones users use other type of operating systems as well. By covering all of these main types of mobile operating system, it can increase the compatibility of the system. Therefore, more users will be able to use the system and be more beneficial to society.

## IV. DISCUSSION

This paper gives a brief comparison of all the above systems described. The systems that have been studied have certain common features. All these systems use a basic underlying communications technology. The advantages and drawbacks of the system derive from this underlying technology. All the systems have a control circuitry that is used to interface with the electrical appliances. There has to be a common command system that will be used to issue commands to the control circuits. The next important feature of the system is the user interface. This determines how the user will interact with the system and extent of control the user exerts over the system. According to my knowledge the user interface should come with a web application which has a linked mobile application. So that people who are using all kinds of operating systems can access the system without having a problem. Such a system should also have the feature of being easy to install and user friendly as well. Only then can automated homes become commercially viable from user to user. There should be a lot of thought put into the design of the user interface for the project. This influences the usability of the system. Most systems also have security features to ensure only authorized access.

## V. CONCLUSION

Future scope for the home automation systems involves making homes even smarter than today. Homes can be interfaced with various kinds of sensors such as motion sensors, light sensors and temperature sensors and provide automated toggling of devices based on conditions. More

energy can be conserved by ensuring occupation of the house before turning on devices and checking brightness and turning off lights if not necessary. The system can be integrated closely with home security solutions to allow greater control and safety for home owners. The next stage would be to extend this system to automate a large scale environment, such as offices and factories.

Based on all the systems surveyed with their advantages and drawbacks, this paper presents the features to be possessed by an ideal system which was created for home automation. By reviewing those research papers which related to the area of home automation and related works to that area. Finally the reader can get a brief idea about what should he do and what shouldn't do during the implementation process. Plug and play capabilities might be an added bonus for the system as a further development. Ease of adding a new device to an automated house will play an important role in taking forward the systems commercially.

This paper mainly concerns about two major areas which are home automation and report generating. It has mentioned there are various options. But all these may not provide a desired accuracy therefore depending on the problem domain choosing the best option would be of paramount importance for a successful result.

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# COMMUNICABLE DISEASE SURVEILLANCE AND RESPONSE SYSTEM

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**Abstract** - The latest studies estimate in Sri Lanka around 5 million people living in areas of dengue risk, over 32,000 infections so far in this year and more than 50 deaths. Though government of Sri Lanka has spent millions, precise system not yet been instigated. It is learned that the Public Health Inspectors (PHI) are the key people to be addressed to implement proper communicable disease surveillance system. Present manual system retard the entire process of reporting patients and breeding locations of mosquitos and other relevant information and never been adopted a centralized mechanism. Awareness and the active participation of the community is a vital factor to successes such a system. Hence this system is a participatory Web-Mobile and GIS based system which developed to address burden of dengue and other similar epidemic disseises in Sri Lanka. This system enriched with latest technologies in mobile applications, Web and Geographic Information Systems. This system is capable of monitor trends in the distribution and spread of dengue over time geographically for early response also possible to report dengue breeding locations and patient's locations with various related data using mobile applications further automated alerting system has developed for PHIs and related authorities based on community mapping. Drone mapping is used to map dengue risk areas, Water logged

places, malfunctioning drainage systems, garbage dumps, and/or any potential endemic areas will be marked as risk areas with the use of aerial photos and videos. Live monitoring of the dengue risk areas using drone is a vital factor hence this system get the live streams from the high flying drones in-order to monitor present condition of the risk areas. Hotspot analysis and various statistics reports enhance the risks of individual's surroundings.

**Keywords** - Epidemic diseases, Web GIS, Drone Mapping, Mobile Applications

## I. INTRODUCTION

The lack of planning, inadequate housing, water, sewage, and waste management has created ideal conditions for dengue viruses and other epidemic diseases. The latest studies estimate in Sri Lanka around 5 million people living in areas of risk, over 32,000 infections so far in this year, and more than 50 deaths. Thus, ignored for many years, only recently has the potential magnitude of the dengue problem been acknowledged by policymakers and funding agencies. Government of Sri Lanka has spent millions to developed dengue reporting, analysis and prediction systems, thus never been able to reduce

the impact of the dengue due to burden of practical applicability and lack of community participation. The aim of the research is to develop web-GIS based system to reduce the impact of the epidemic diseases and to improve the efficiency of the Public Health Inspectors (PHI) by introducing digital formats and also to increase the participation of the community.

## II. METHODOLOGY

This system consist of two major web map engines, in-house (CRD) map engine and the ArcGIS server, images and the live video from drone will be stored in the CRD server while inputs from the mobile application store in both CRD server and the ArcGIS server. Public Health Inspectors (PHI) has to login with their user names and password to the same mobile application which use by the general public. If there is any dengue suspicion area general public can report those areas using mobile application which is highly user-friendly application. PHIs can report the risk areas as well as dengue patient locations. Drone mapping use to map the dengue risk areas using aerial photography and live stream for live monitoring of risk areas. When dengue breeding location reported by the community warning message will be sent to the PHI and relevant government authorities using ArcGIS Modelbuilder and Python scripts. Web application and a mobile application developed to report dengue patient who are admitted to the government or a private hospital by digitizing current manual procedures. General public can access to the web page and perform various analysis depends on their requirements.



FIGURE 1 - METHODOLOGY

## III. EXPERIMENTAL DESIGN

This research involved developing two different Android applications to address the aforesaid need. One Android application to report the dengue breeding locations, container type, etc... and to send data to MySQL database with the X, Y coordinates through HTTP header. The other Android application developed to reports dengue patient's information.

Php timer script running on Apache server will access to the store in My SQL and automatically store data in MS SQL Server Express. Incident's locations stored in MS SQL Server Express will be accessed through ArcGIS 10.1 in-order to analyse the risk and to send warning messages to the inhabitants who would possibly be affected with the calculated risk factors (High Risk Zone, Medium Risk Zone and Low Risk Zone) through e-mails and SMS and also SMS alert will be sent to the responsible PHI of the dengue reported area. This entire process has been automated using "Model Builder" in ArcGIS to increase the speed of the process and to reduce human errors.

For assigning calculated risk for individuals Visual Basic Script has been used and two separate python scripts have been used within the ArcGIS "Model Builder" to send emails and SMS. Furthermore the system will send detail report to the relevant government organizations through e-mail and SMS.

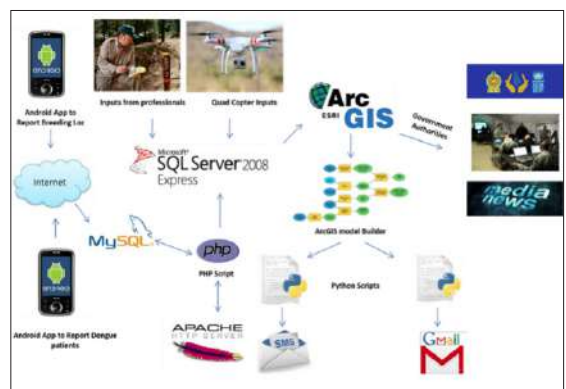


Figure 2 - Experimental design

## IV. RESULTS AND DISCUSSION

This system been tested in Dehiwala and Mount Lavinia areas during past two years and conducted awareness programs for the PHIs and other relevant authorities. As per the interviews with the PHIs this system is a vital requirement and reduced the complexity for their duties



Figure 3–Main page

In the main page of the web system users can view the current threat of the dengue fever for individual district according to the number of reported patients and breeding locations. This thematic colour map changing automatically whenever new record is submitted to the system and also hotspot analysis can be seen which generated through the ArcGIS Server. Dengue analysis based on the Geography always provides better understanding, thus this system use ArcGIS server to analyse and display data.



Figure 4–Statistical charts

Statistical analysis charts are developed by considering breeding locations, patients and the rainfall which can be use for the prediction and analysis.

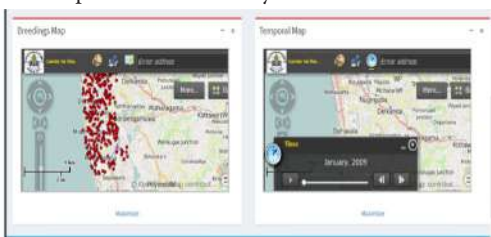


Figure 5–Android inputs and temporal analysis

Android mobile application is able to send data directly to the ArcGIS server which is one of the significant research finding in this research. Users also can view the breeding map and the temporal analysis of spreading dengue patient reported locations.

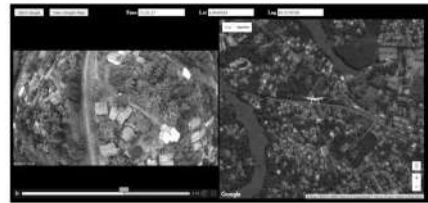


Figure 6 - Drone mapping

Drone mapping been used to map dengue risk areas. Water logged places, malfunctioning drainage systems, garbage dumps, and/or any potential endemic area marked as risk areas with the use of aerial photos and videos. Live monitoring of the dengue risk areas using drone is a vital factor hence this system get the live streams from the high flying drones in-order to monitor present condition of the risk areas and system displays the current position of the drone over the Google map using X, Y coordinates receiving by the GPS of the drone.

## V. CONCLUSION

GIS play vital role in early warning systems, disaster management process and in epidemic diseases outbreaks. With the development of the new technology there are many options to be adopted and customize into our own systems. Selecting best and most suitable option is a vital factor since warning systems and epidemic analysis is dealing with human life and the valuable assets of the country.

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# DIGITAL CERTIFICATE MANAGEMENT SYSTEM FOR eHEALTH AND mHEALTH PRACTITIONERS IN SRI LANKA TO SECURE MEDICAL DATA

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**Abstract** - eHealth and mHealth systems are getting more popular today; yet, vulnerabilities are much higher when the sensitive medical data being transferred through public networks. Therefore, it is essential to have a digital identification and authentication mechanism to authenticate peers in a digital world. Especially, it will help to avoid attacks such as man-in-the-middle attack. Although the digital certificates can solve this issue, it has not been used by the general public yet to protect their digital data. This is mainly due to their limited knowledge in IT and the complexity of the process. Thus, it is required to have a simple security tool to support encryption, digital signature, digital authentication, and integrity verification. However, we have developed a digital certificate management system to facilitate all these features including creating asymmetric key pairs, generating, signing, chaining and revoking certificates, and signing and verifying digital contents. Because it is a Java based application, it is platform independent; thus portable. In backend, it uses OpenSSL library. Moreover, it is capable of managing present RSA based certificates as well as the novel Elliptic Curve (EC) based certificates. Thus, it is more robust, future-proof and well-suited for mobile devices. However, a usability test was performed to evaluate its usability, efficiency and the effectiveness. 47 undergraduate and postgraduate students were voluntarily

attended for the test and their responses were critically analysed. Compare to the conventional command line based method, 100% of user satisfaction has been gained by the developed tool. In conclusion, it is a simple, free and open source software for the public to secure their digital data.

**Keywords** - Computer Security, Digital Certificate, PKI, eHealth & mHealth.

## I. INTRODUCTION

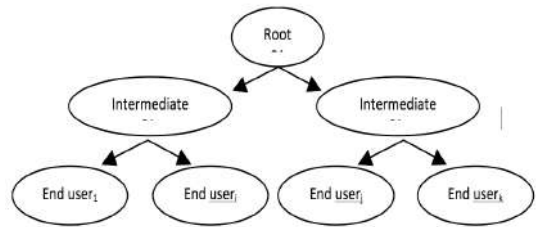
Health and mHealth systems are getting more popular today; yet, vulnerabilities are much higher when the sensitive medical data being transferred through public networks. As the IBM survey in 2015, medical data has the highest per record security cost. Moreover, in USA, medical identity theft is the most rising crime today. All these emphasize the criticalness of security of medical data. However, identity cards play an important role in human society by providing a convenient way to prove the identity of a person to others. In the same way, digital certificates provide a way to prove the identity of a person or a device uniquely in the digital world. As more and more devices getting connected to public networks with the advancement of Mobile technology, Internet, and Internet



of Things (IoT), it has become a crucial requirement to identify them and their activities uniquely. Especially, it is essential to avoid man-in-the-middle attacks. At present, digital certificates are being used to identify mainly servers, not the clients. This is because of the complexity of Issuing, distributing, renewing, revoking, and validating certificates. As a result neither servers nor the peers would be able to verify the real originator of the message. Thus, it would be not possible to implement security services such as non-repudiation. However, if one obtained a digital certificate, he/she has to pay a fee for the certificate. Therefore, the communities with thousands of user like universities, hospitals, government departments, agencies, etc. have to spend a huge amount of money for this annually. If an organization wants to identify its clients, it needs to have specialized people to manage those certificates. Besides, organizations can not have local authority on their identification system if they use the global verification chain as external parties can create valid certificates for them. Moreover, present encryption mechanisms are not suited to secure real-time video data in a mobile environment due to its time complexity. Therefore, it is necessary to have a simple tool to manage digital certificates within an organization especially in a non-technical environment like health. The objective of this research is to develop a simple but novel and robust digital certificate management system for eHealth and mHealth practitioners in Sri Lanka to manage their medical data securely (Abdalla et al., 2000; Al Nuaimi et al., n.d.; Andrews et al., n.d.; Armknecht et al., n.d.; Brands, n.d.; Gerard et al., n.d.; Gui-hong et al., n.d.; Dahlman, 2014; Zhou & al, 2007)

## II. BACKGROUND

When a client visits a web site which has a certificate installed in the server, the web browser can verify the validity of that certificate through its certificate authorities. Especially, this is very helpful to avoid DNS attacks when you are visiting sites like email, internet banking or payment sites like PayPal. In fact, digital certificates help you to identify any site before you enter your sensitive data such as passwords or pin numbers to that site or before you download software from it.



**Figure 1: Certificate authority hierarchy**

Thawte, GlobalSign, Combo, and DigiCert are some of the root certificate authorities who provide this service. However, there are number of intermediate certificate authorities in the world who are extending the service of those root certificate authorities. Practically it is not possible to installed signatures of all certificate authorities in a web browser. Thus, chain validation is being used. In chain validation, browser repeats the validation process till it gets the signature of a known trusted certificate authority (Nash et al., n.d.; Hunter et al., n.d.; Koehler, n.d.; Leavitt, n.d.). Figure 1 shows how the certificate authority hierarchy is organized.

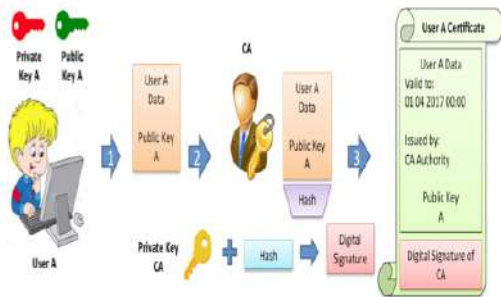
## III. METHODOLOGY

A free and open source library for cryptography named OpenSSL has been using in the backend to do the all cryptographic works. Thus it will automatically fix the bugs as you update the library. In order to make it platform independent, Java has been chosen as the development language. For the simplicity of the user, tasks have been divided into tabs so that user can focus on a single task at a time. Tabs have been organized in a way that it takes user from one step to the other as in wizards. Further, defaults values have been given to minimize the user inputs as well as give insight about the value that required for that field. Moreover, users can customize these values and save their own default values for later use.

Main steps of the process can be summarized as key pair generation, certificate sign request generation, signing a certificate, viewing a certificate, verifying a certificate, chaining certificate authorities, generating revoke list, and generating renew request. Apart from that, message digest generation, signing documents and verifying digital signatures can also be performed.

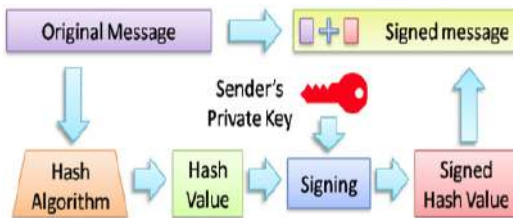
**A. Creating a Digital Certificate**

Figure 2 shows how the digital certificate is created by putting CA's signature for user's details and his/her public key.



**Figure 2: CA and Signing Digital Certificates**

**B. Generating a Digital Signature**

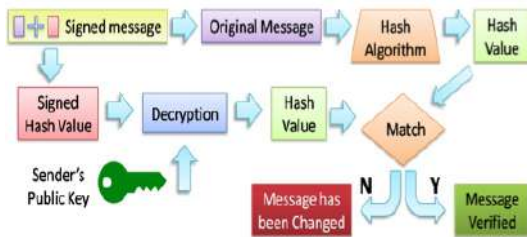


**Figure 3: Signing a message**

Figure 3 shows how the digital signature is generated using the message digest and the private key of the sender. This will provide a way for receiver to verify the integrity of the message and to authenticate the sender of the message.

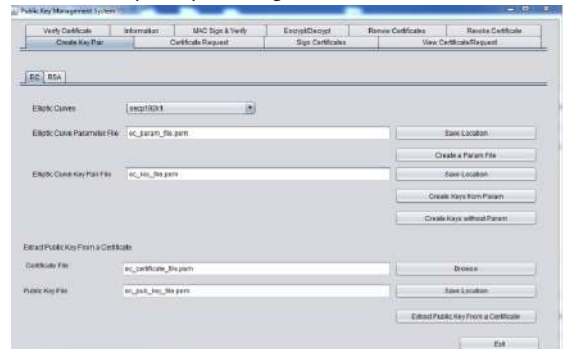
**C. Verifying the Integrity and Sender**

Figure 4 shows how that verification process and authentication are happening.



**Figure 4: Verifying a Signed Message**

Finally, a usability study was performed with the help of university students. First, they were given command line OpenSSL and a list of commands to execute. Secondly, they were asked to do the same task using the tool developed by this research. Thirdly, they have been asked to rate their experiences of both methods and finally, their feedbacks were critically analysis using statistical methods.



**Figure 5: Key Generation**

**IV. RESULTS AND DISCUSSION**

Present global public key infrastructure is based on RSA asymmetric cryptography system. However, in this research we have used a novel and robust cryptography method called Elliptic curve cryptography. Moreover, it is efficient than the present RSA method as it can provide the same security under 30 times less key size. Hence, it is suitable for mobile devices too. Elliptic curves are exponential. Besides, it is based on new mathematics on finite field rather than the integer factorisation. Thus, it is more robust than the present RSA method. Therefore, this public key infrastructure is more robust, future-proof and well-suited for mobile devices.

Figure 5 shows how the key pair and parameter files being created. Figure 6 shows how to sign a certificate using a root or an intermediate certificate. Besides, it allows you to create self sign certificates as well as root and intermediate certificates. Initially it was decided to carry out the usability test with the help of medical students by considering their higher IT knowledge compare to Doctors and other health workers. However, in the pre-test, it was found that most of the medical students were very uncomfortable with the command line although they have a relatively good knowledge in IT. Therefore, the computer science and IT undergraduate and post graduate students were chosen for the final test in order to compare user experiences of both. 47 students were voluntarily attended on the test.

Most of them were familiar with the OpenSSL. Thus they were able to do all the command line tasks successfully with minor mistakes. Results show that 100% of the testers were voted this as a convenient, efficient, and less error prone tool for the public key management. In pre-test, some of the experts favour command line tool rather than this because it allows more freedom for customizing commands. However, the objective of this research is to empower general public with user friendly tool for public key cryptography and infrastructure management. Thus, the res



**Figure 6: Signing Certificates**

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# BUILDING DIGITALLY INCLUSIVE DIFFERENTLY ABLED COMMUNITY IN SRI LANKA: AN INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) POLICY FRAMEWORK

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**Abstract** - Digital inclusion (DI) is an ability of individual and groups to access and use information communication technology. In the Sri Lankan context, it is a problem among disabled people. This study investigates influencing factors of digital inclusion in Sri Lankan disabled community. Research methodology consists of a survey done at Ranaviru apparels Yakkala, Sri Lanka in the phase one of this study. It interviewed 180 disabled people who work at this institute. Descriptive statistic method was used for data analysis. According to results, current website development issues, difficulties in software accessibility, human perception on technology, financial difficulties to purchase and use of equipment indicated as major issues. A multidimensional framework is recommended to overcome issues. Standardization of web and internet facilities, concentration on user friendliness in software development process, infrastructure development, social and cultural changers, financial support for disabled people and special training and education on technology are recommended in the framework. This framework can be considered as a tool for building digitally inclusive differently abled community in Sri Lanka

**Keywords** - Disability Digital Divide, Digital inclusion,

## I. INTRODUCTION

### A. Background to the Study

Accessibility issues for disabled people are a pertinent issue take into consideration in the modern globalised world. In Sri Lanka also this is a influencing topic because many people suffered due to road accident and three decade of civil war. In Sri Lankan civilian who was born without any physical disability became disabled because of civil war in the country. This adds a severe disadvantage for the Nation. Due to the disability issue many people are getting disadvantage of accessing equal opportunities in the country. This is specially happen when they are using new technologies in their office work and maintaining social relationships and accessing public infrastructure. County policy makers are considering overcoming these issues and ensuring that all citizens are enabling access to new digital technologies.

Objective of this study is to propose a framework to overcome issues which influence for digital inclusion among Sri Lankan differently abled community.

This research basically divided into three different research questions. First question is to finds out what are

the main factors influencing for digital inclusion among differently abled community. Second question is to find out how to overcome the above identified problems and issues. Third question is to find out how to validate the proposed solutions.

Outcome of the research propose a framework and validate method to overcome the digital inclusion issues in Sri Lanka.

## II. LITERATURE REVIEW

### Definitions

Research on digital inequality studies how different social groups access technologies and how this access contributes to offline advantages and disadvantages (Chen, 2013). The use of technology to communicate has become an essential and socially acceptable aspect of most people's lives and it is becoming increasingly difficult to distinguish between the "digital world" and the "real world" (Helsper, 2008; Ritchie & Blanck, 2003). Hence, Digital Inclusion is an increasingly important social issue, reflecting imperatives, opportunities, and considerations about human rights, equity, issues of identity, language, social participation, community and civic engagement, and opportunity pertaining to the digital world (Castells, 1997; Warschauer, 2003).

### Disability

According to the Charlton (1998) and Driedger (1989) study disability is complex, dynamic, multidimensional, and contested. Over recent decades, the disabled people's movement together with world report on disability numerous researchers from the social and health sciences have identified the role of social and physical barriers in disability (Barnes, 1991). More recent thinking around disability indicates that the identification of deficits should be integral to the identification of necessary support people require to overcome these challenges and that people's strengths should also be highlighted (Schalock et al., 2010).

According to the Sen (2009) Disability is a development issue, because of its bidirectional link to poverty: disability may increase the risk of poverty, and poverty may increase the risk of disability. This disadvantaged group of community also face some difficulties of access computers, mobiles and Internet. It causes for many reasons such as poverty, lack of awareness, language issues, Social and ethical background and lack of Interest.

### Digital Divide

The exclusion of people with disability from the online world has been referred to as one important component of the "digital divide" (Dobransky & Hargittai, 2006; Warschauer, 2003). People with disabilities are considered likely to be able to make especially fruitful use of the online world to help overcome disabling barriers they face caused by societal attitudes, organisation, and structuring which mean that their differences, for instance physical, sensory, intellectual or psychological impairments, are not adequately considered and so they are discriminated against. For example: a person with considerable physical impairments can pursue online education meaning there is less need to leave home; a person with a significant visual impairment can gain access to documents by downloading them and converting the text to speech; a person with a learning disability can socialise and make or maintain friendships from home. Sadly though, disabled people, because of poverty, lack of social support or other reasons, frequently lack the means to get online and if they can, may not be adequately equipped or supported (Chadwick et al., 2013; Hoppestad, 2013).

According to the Roger et.al (anon) Digital divide is a latest evocative term that refers to differences in access to uses of information technology that are correlated with income, race and ethnicity, gender, age, place of residence, and other measures of socio-economic status. According to them some people have the most powerful computers, the best telephone service and fastest Internet service, as well as a wealth of content and training relevant to their lives. Another group of people do not have access to the newest and best computers, the most reliable telephone service or the fastest or most convenient Internet services. The difference between these two groups is called the Digital Divide.

### Digital inclusion

Crandall and Fisher (2009) suggest digital inclusion is the rallying cry of the twenty-first century. They claim that digital inclusion goes beyond access to computers and the internet for all, regardless of physical, cognitive, or financial ability; it means technological literacy and the ability to access relevant online content and services. Hache and Cullen (2009) extend the definition by arguing that digital inclusion is the process of democratization of access to Information and Communication Technology (ICT) in order to allow for the inclusion of the marginalized in society. They claim that digital inclusion should be seen as a wagon to social inclusion that ensures individuals

and disadvantaged groups have access to the skills to use ICTs, further indicating these individuals will be able to participate in and benefit from electronic-mediated, growing knowledge within an information society.

### III. METHODOLOGY

This research examines the factor need to consider digital inclusion among differently abled community. Therefore literature survey has conducted in the initial stage of the research. Then it is finding out how to overcome the problems and finally it discusses how to implement the solutions and validate them. The methods used to collect and analyse data are discussed below.

#### A. Research Strategy

This research consists of basically a literature study. The core construction of this model are adapted from the theory of Technology Acceptance Model(TAM).Data Sample collected for this study include with literature behind the disability digital divide in the globe, social construction of disability, the development of information technology and internet related technology through a literature survey and global and Sri Lankan corporate policies related to information technology and web accessibility through literature and Interviews had with public and private sector organization. In order to identify real requirement of differently able community in relation to Information Technology, interviews were conducted with a range of disabled people who effected from Sri Lankan civil war.

#### B. Data Collection

Data collected in this study via an observation and interviews and literature study. Researcher has model the solution basically initial survey conducted at Sri Lanka Army CLI, unit Panagoda. Structured interviews were conducted. This study interviewed 314 differently abled people using a non-probability sampling method such as convenience sampling. Age group of the participants was between 20 to 50 years old. Participants for this study were selected from different communities, disabled categories and various geographical locations. Data is collected in under the different levels of technology usage under the three themes such as basic, intermediate and advance. In the second phase of this study conducted at the Ranaviru Apparel Yakkala Branch. Study conducted with 180 disabled employees. Structured interviews

were conducted. Participants for this study were selected again from different Age, Type of Work, Gender, Living arrangement, Employment status, Management Level and Income.

Both of these initial study result focuses to model the solution framework and propose validation method in this study.

#### C. Data Analysis Framework

**Table 1: Different type of digital inclusion among differently abled community in Sri Lanka**

Notation	Type of Accessibility	Variable Description
B1	Basic	Telephone Use
B2	Basic	Web Access – Information Search and Email use
B3	Basic	Computer Use
I1	Intermediate	Office application Use
I2	Intermediate	Multimedia use
I3	Intermediate	Screen reader Software use
I4	Intermediate	Social media use
A1	Advance	IT Administration
A2	Advance	S/W Design Development related
A3	Advance	High-tech S/W Use (Eg. CAD/CAM Operations)

In the second survey has been more focuses on in-depth analysis of the factors influence for digital inclusion. The main factors divided into three main dimensions. They are perception on technology, technological factors and other inhibiting factors. They are given in the below Table 2.

**Table 2: Factors influencing for digital inclusion**

Perception on Technology	Technical problems and issues	Other inhibiting factors
Income(PI)	web standard issues(TW)	Cost of Software Technology(OC)
Education(PE)	Software incompatibility/ user friendliness (TS)	Lack of Awareness(OLA)
Desire for learning(PL)		Lack of Direction(OLD)
Entertainment(PEN)		Lack of Skills(OLS)
Culture(PC)		Lack of resources(OLR)
		Lac of Training(OLT)

Collected data were analysed based on qualitative approach according to thirteen themes. Analysis techniques used in this research were co-relation on the above factors on disability digital divide. Factors analysed based on the three main viewpoints including perception on technology, Technical problems and issues and other Inhibit factors.

In order to identify the factors affecting to digital inclusion factors classify under three viewpoints. The first theme is perception on technologies. Under this five main factors were taken into consideration. Such as person income, education background, personnel interest on learning new technologies, use of technology to watching films, listing music and other entertainment activities. Then, it considers how the person culture effects to disability digital divide.

Next dimension of the factor analysis focuses on Technical problems and issues. Basically it discusses web standard issues and software incompatibility or the friendliness of the software.

Finally, it concerns the other inhibiting factors which causes for digital inclusion such as cost of software technology. Awareness of the technology, Use only some basic technologies without proper direction. Some people have proper direction but due to disability they suffer with have lack of skills. Next it considers the resources issues. Most of the disabled users are facing with some financial difficulties. Therefore, most of the assistive technologies cannot be purchased.

#### IV. RESULT AND DISCUSSION

Descriptive statistics of the sample, the general information of differently abled community (age, experience in technology), and the other details are reported in Table 3.

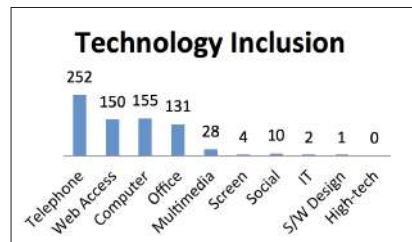
**Table 3: Use of Technology**

Description	Respondent	Percentage
Telephone Use	252	98 %
Web Access	150	58 %
Computer Use	155	60 %
Office application Use	131	51 %
Multimedia use	28	11 %
Screen reader Software use	4	0 %
Social media use	10	0 %
IT Administration	2	0 %
S/W Design Development related	1	0 %
High-tech S/W Use	0	0 %

According to the descriptive statistics three main areas were taken into consideration such as current ICT knowledge, Relevance of IT for job related activities and Interest of ICT for future needs. Result of the study indicated that the level of Current ICT Knowledge is high among the age 25 to 28. Reason for this could be that younger generation is using more smart phones and they are likes to incorporate new technologies. Adaption level is high among this community.

English language issues among this community can be considered as a significant issue. 90 percentage of the participant had English language issues and they are working in Sinhala language. Therefore, majority are having language barriers to use technology. Therefore, most of them are in the medium level . Most of the computer users are using office package in day today life at the same time some participants in young age like to use innovative technology. But employees who are closer to retirement age do not like to learn new technologies. Their ambition is to have their pension and stay at home. But they are interested in giving IT education to their children rather than learning themselves.

On the other hand according the findings social media usage is 0% among the community. Restriction of social media with in the office hours and office computer are causes for this result. Most of them do not have a computer at home and as a result less usage of social media among the community.



**Figure 01 : Technology inclusion**

#### Factors influencing for digital inclusion

In the next survey conducted at the Ranaviru Apparel Yakkala mainly focuses the factors that are influencing for digital inclusion among the disabled community. Descriptive statistics are discussed in the Table 4.

In this study different type of disabled participant were interviewed. It was included with 53 people with having serious difficulties in eyes, 05 hearing problems, 06 people with upper Limbs and 06 with lower limbs. In addition to

that 107 people with different complications of disabilities were involved. All together 177 participants were taken in to this research.

**Table 4: Descriptive statistics of factors influencing for digital inclusion**

<b>Age</b>	18-25	25-35	36-45	>45
	23	90	58	6
<b>Type of Work</b>	Admin		Operational	
	19		158	
<b>Language</b>	Sinhala	Tamil	English	
	177	-	-	
<b>Gender</b>	Male		Female	
	175		2	
<b>Leaving Arrangements</b>	With Patents		112	
	Shared accommodation with friends		7	
	With Partner		41	
	Living alone		1	
	In a rehabilitation centre		15	
	Healing Home for War heroes		1	
<b>Employment Status</b>	Full Time		177	
	Middle		55	
<b>Income</b>	Low		122	
	Less than Rs. 15,000		0	
	Rs. 15,000 – Rs. 25,000		5	
	Rs. 25,001 – Rs. 35,000		71	
	Rs. 35,001 – Rs. 45,000		89	
	Rs. 45,001 – Rs. 60,000		12	
	➤ 60,001		0	

According to the analysis, factors that are influencing digital inclusion among disabled community are categorised into five point likert scale. According to the responses given basically categorised the response rates in to 5 categories according to the following method.

Basically total responses value divided by 5 based on the five point likert scale. Then it is equally divided into 36, 72, 108, 140 and grater.

If response rate for a given Factor (F) is less than or equal 36 then points given to this factor is 1. If F greater than 37 or less than or equal 72 then points given to this factor is 2. Then If F greater than 73 or less than or equal 108 points given to this factor is 3. If F greater than 109 or less than or equal 140 points then given to this factor is 4. If F greater than 141 then this factor is assign by 5 point.

Findings are given in the Table 5.

Factor relate to Digital Inclusion	Very important(5)	Important(4)	50-50 (3)	Less important(2)	Not important(1)
Income(PI)			3		
Education(PE)			3		
Desire for learning(PL)			3		
Entertainment(PEN)			3		
Culture(PC)	5				
web standard issues(TW)				2	
Software incompatibility/user friendliness (TS)			3		
Cost of Software Technology(OC)					1
Lack of Awareness(OLA)					1
Lack of Direction(OLD)				2	
Lack of Skills(OLS)			3		
Lack of resources(OLR)			3		
Lack of Training(OLT)	5				

Based on the above finding it is indicated that different factors are affecting in different level.



## Overcoming Digital inclusion factors

The second research question is to find out a suitable method to solve the issues. Based on the literature and survey findings, solution framework describe below figure 2.

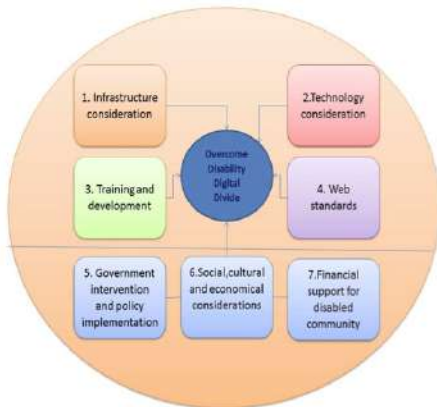


Figure 2: digital inclusion solution framework

### 1. Infrastructure Consideration

Smart objects connected through radio signals, Bluetooth and wireless connectivity and Internet of Things (IOT) base Solutions. In addition to that one main factor that needs to improve the digital inclusion among the disabled community is the telecommunication infrastructure changers.

When the roads are newly constructed, implementing obstacle detection will help blind people to detect obstacle. Object interconnected and improves the usability. Web base solutions for disabled are need higher bandwidth special on accessing computers and internet. Community centres are far away and difficult to travel for disable people.

### 2. Technology Consideration

Promote low cost technologies are one main solution to overcome the digital inclusion. Invest to development on low cost solution and promote research and development on low cost technology solutions

Promote Language friendly Applications. Develop and test the language base solutions such as text to voice converter in Sinhala and Tamil language.

Mobile technology considerations are another finding to make disable people incisive on digital technologies.

Follow the mobile accessibility guidelines. Design mobile accessibility guidelines (Ex. BBC guidelines for mobile development for disabled)

Computer technology considerations are another main factor. Computer technology considerations divide according to the barriers faced by the disabled community. These barriers can be grouped into three functional categories: barriers to providing computer input, interpreting output, and reading supporting documentation.

### 3. Training and Development

Special Design IT training for middle age people will be helpful for digital inclusion. Implementing a disabled training module is another solution. Special Design IT training for old people needed to consider. Specific user oriented training for old disable users

### 4. Web Standards

Promote W3C guide lines among web developers. Identify the problems of current implementations  
Awareness on the W3C guidelines

### 5. Government intervention and policy implementation

Technology barriers. Study the technological requirement of disabled community and identify the policy issues related to technology

### 6. Social, Cultural and economic consideration

Social and cultural influences directly correlate with digital inclusion. Influencing by Media could be helpful to make disabled people digitally inclusive. In order to socially interaction differently abled people need to be digitally inclusive. Promote social inter connection with relatives, friend and communicate with similar groups via social media

### 7. Financial support for disabled community

Financial difficulties among the disabled community make them digitally exclusive. Special loan system to buy smart and computer devises and provide special low cost solutions will make them more digitally inclusive.

## V. CONCLUSION AND RECOMMENDATION

According to the above two surveys conducted for this research, indicated that digital exclusion is an issue in Sri Lankan differently abled community. Therefore, it is recommended a solution framework for policymakers to consider. It is recommended to validate this solution frame work. Recommended validation are given in the following Table 6.

**Table 6: Validation framework**

Solution to overcome disability digital divide	Validation method
When the roads are newly constructed, implementing obstacle detection will help blind people to detect obstacle. Object interconnected and improve the usability	Study the case studies on different implementations has been done in other countries.
Web base solutions for disabled are need higher bandwidth special on accessing computers and internet. Community centers are far away and difficult to travel for disable people	Conducing a survey to identify the technology adoption between disable people who are accessing high speed bandwidth and not
Invest to development on low cost solution and promote research and development on low cost technology solutions	Conduct a survey to identify the technology adaption differences between the people who are using low cost technologies and high cost technologies.
Develop and test the language base solutions .Text to voice converter in Sinhala and Tamil language.	Get the feedback of the user satisfaction to prove the factor
Follow the mobile accessibility guidelines Design mobile accessibility guidelines (Eg. BBC guidelines for mobile development for disabled)	Conducting a comparative analysis to identify the effectiveness of the guidelines for disable people. (Pre implementation and post implementation will be validated)
Computer technology considerations divide according to the barriers faced by the disabled community. These barriers can be grouped into three functional categories: barriers to providing computer input, interpreting output, and reading supporting documentation.	Design an assessment evaluation forms to get the user satisfaction of implementations
Implementing a disabled training module	Survey result to identify the user satisfaction of the training and usability
Specific user oriented training for old disable users	Survey result to identify the user satisfaction of the training and usability
Identify the problems of current implementations Awareness on the W3Cguidelines	Survey on disabled user satisfaction on before and after implementation of W3C standards for a web site

Study the technological requirement of disabled community and identify the policy issues related to technology	Propose sample policy changers by analysis of other case studies using in other countries.
Influencing by Media	Develop a video's to present the importance of IT for disabled community. Conducting a survey to measure the improvement of usage by the technology after awareness through media
Promote social inter connection with relatives, friend and communicate with similar groups via social media	Create a social media group and observe the connectivity among the disabled community
Special loan system to buy smart and computer devises Special low cost solutions	Survey on financially capable and incapable disabled community usage. Monitor and assess the improvement of the technology adoption after providing financial support

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# AN IMAGE PROCESSING APPLICATION FOR DIAGNOSING ACUTE LYMPHOBLASTIC LEUKEMIA (ALL)

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**Abstract** - Leukemia, simply called “Blood cancer” is a fatal disease where the white blood cells (WBC) increases in bone marrow and peripheral blood. Acute lymphoblastic leukemia (ALL) is one of the most common types of leukemia aroused by accumulation and overproduction of immature and cancerous cells known as lymphoblasts. Presently, the diagnosis of ALL includes performing a full blood count, blood picture, bone marrow biopsy, cytochemical stain, immunophenotyping and cytogenetics. These techniques are highly tedious, costly, requires expertise of hematologists and available only in few hospitals. Therefore, as an alternative, use of image processing to diagnose ALL would become an effective solution. Although, several research groups have employed image processing to identify ALL, recognition and splitting of overlapping red blood cells (RBC) with WBC has yet been a challenging issue. This paper is about an application which includes an image processing algorithm to diagnose ALL while attempting to solve the above mentioned issue of overlapping cells. The algorithm is also extended to detect the quality devastation in blood films in terms of storing them for prolonged period. The inputs for this application are microscopic peripheral blood images of ALL patients obtained from Department of Pathology Clinic at Faculty of Medicine, University of Colombo. Then, image processing techniques; image enhancement,

segmentation, feature extraction and classification are performed. For the detection and diagnosis of leukemia, segmentation using morphological operations in OpenCV Python and classification using K-Nearest Neighbour and Support vector machine implementations has been proposed in this research. It is observed that the proposed algorithm has led to a high accuracy in diagnosing ALL. The system also includes a PHP based web application that serves hematologists, doctors and patients to log in to their specific user accounts and make records, insert details and view diagnosing reports.

**Keywords** - Acute Lymphoblastic Leukemia, Image processing, Segmentation and Feature extraction, Classification

## I. INTRODUCTION

Blood is one of the most important materials of the human body as it is the principle agent that make humans live. Human blood consists of two major parts; plasma and cells. The peripheral blood cells consist of three main components; Red blood cells (RBC), White blood cells (WBC) and platelets. There are five types of WBCs; Neutrophils (40-75%), Lymphocytes (20-45%),

Eosinophils (1-8%), Monocytes (0-10%), Basophils (0.5-1%). Leukemia, simply called “Blood cancer” in which usually the number of WBC increase in the bone marrow and peripheral blood. These leukemic cells (usually immature) replace the normal blood cells and causes malfunction of the bone marrow and peripheral blood. Furthermore, excess amount of these cells travels to other sites such as liver, spleen to maintain normal cells production. Later, the leukemia cells also invade other organs causing them to malfunction (Hoffbrand et al, 2004).

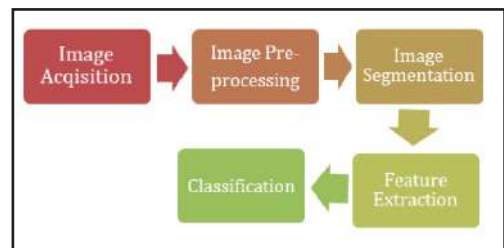
There are two main types of leukemia according to the morphology of cells in the bone marrow. They termed as acute & chronic Leukemia. Acute leukemia involves the rapid overgrowth of very immature blood cells whereas chronic leukemia involves the overgrowth of somewhat mature blood cells in the bone marrow compared to acute type. In the French-American-British (FAB) classification (Bennett et. al, 1976), acute leukemia is further categorized into two groups based on the white blood cell from which the malignancy originates from. They are acute lymphoblastic leukemia (ALL) is caused by abnormal lymphoid cells, and acute myeloid leukemia (AML) is caused by abnormal myeloid cells in the bone marrow (Hoffbrand et al, 2004). The predominant abnormal cells in the ALL are lymphoblasts.

The detection, identification and classification of leukemia normally follow series of steps. They are full blood count, examination of blood picture, bone marrow & trephine biopsy, immunophenotyping and cytogenetics (Hughes-Jones et. al, 2004; Hoffbrand and Lewis 1995; Purohit, 2000; Cui et. al, 2004). The whole process takes about 3-4 days and also needs a well-trained experienced staff. However, early diagnosis of leukemia contributes to early treatment and proper management of patients. Furthermore, manual detection procedure stated above is a highly tedious task that involves the effort of hematologists and other supporting staff as it is intensively slow, costly, time consuming. Even though advanced techniques are being used there may be errors especially diagnosing subtypes. Image processing and data mining fields have provided fast, cost effective and accurate solutions in fields such as medical image management, image data mining, bioimaging, neuroimaging and virtual reality in medical visualization (Scholl et al., 2011; Hegadi, 2010). Researches have been conducted for the detection and counting of red blood cells, white blood cells and to diagnose diseases like anaemia, malaria and deficiency of vitamin B12 using

blood images (Vaghela et al., 2015). Furthermore, Image Processing techniques are the used in detecting cancer cells (Patil and Jain, 2014). Image processing is also been used in diagnosing leukemic cells in blood samples. Techniques such as Image acquisition, pre-processing, segmentation, Feature extraction and classification have been used in the diagnosis.

## II. LITERATURE REVIEW

Presently, a considerable contribution has been done by researchers in the aim of ALL detection using image processing. The common flow of the image processing techniques that is used in diagnosis can be illustrated by below figure.



**Figure 1. Flow of ALL diagnosis**

The researches done so far are different from the segmentation methods and classification methods they have used. A review done on image processing techniques have been elaborated in this section.

### A. Segmentation methods

1) Watershed segmentation: “Watershed” refers to a ridge that splits areas drained by different river systems. Watershed lines are defined on the nodes, edges, hybrid lines on both nodes and edges and in continuous domain. Watershed segmentation is an easy method for the detection of WBC but requires best quality images in order to achieve a better accuracy (MAHAJA et al., 2014).

2) Fuzzy C Means Clustering (FCM): This data clustering technique groups a dataset into n clusters with all data points in that dataset belong to each and every cluster to a certain degree. FCM result is much accurate and it’s able to measuring nucleus boundaries with shape, colour and texture, but it’s difficult in classification of lymphoblast in to its sub types through this segmentation (MAHAJA et al., 2014; Viswanathan, 2015).

3) Fuzzy K-Means Clustering in  $L^*A^*B^*$  colour space: K-Means method is a least squares partitioning method and it divides a collection of objects to K groups of clusters. It considers each object have a location in the space and finds partitions in the image such that objects within each cluster close to each other as likely, and as far from the objects in other clusters as possible. This method is not applicable on incremental data and it cannot give classification with labelled data (Vaghela et al., 2015). Mohapatra and the colleagues have used fuzzy based blood image segmentation for separate out leucocytes from other blood components (Mohapatra et al., 2011).

4) Otsu's method: This is a thresholding method and it's the easiest and fastest method used in segmentation. Thresholding is based on a clip-level named a threshold value used in converting a grayscale image into a binary image. Fabio Scotti has used Otsu's method in nucleus and cytoplasm selection in lymphoblasts and lymphocytes (Scotti, 2005). Their experiments have showed a good performance of this method in separating the nucleus from the cytoplasm.

5) Shadowed C-means clustering (SCM): SCM is a method of partitive clustering developed in the framework of shadowed sets. Unlike rough clustering, in SCM, the choice of threshold parameter is fully automated and the number of clusters is optimized in terms of various validity indices (Mitra et al., 2010). Shadowed clustering can handle overlapping among clusters efficiently and also it can model uncertainty in class boundaries (Mohapatra et al., 2014). The algorithm is robust in the presence of outliers too. However, fuzzy c-means clustering have problems with high dimensional data sets and a large number of prototypes (Oliveira and Pedrycz, 2007).

6) HSI Colour based Segmentation: HSI (Hue, Saturation, Intensity) is a common colour model used in image segmentation. HSI colour model has a good capability of representing the colours of human perception (H. D.Cheng et al., 2006). Nor Hazlyna and the team have conducted a research for ALL detection based on segmentation using HSI and RGB colour space (Nor Hazlyna et al., 2010). The results have shown that the proposed segmentation technique based on HSI has successfully segmented the acute leukemia images while preserving significant features and removing background noise. Singhal and Singh (Singhal and Singh, 2014) and Halim and his colleagues (Halim et al., 2011) are some research groups who have used HSI colour based segmentation in ALL

diagnosis. They have used HSI colour based segmentation as it provides better performance than RGB colour segmentation.

7) K-means clustering: K-means clustering is an unsupervised learning algorithm which involves two simple processes as relegating the given data set and classifying the colligated data sets to the centroid nearest to them. K-means clustering segmentation have been used in identifying the leukemia sub types (Fatma and Sharma, 2014; Ashwini Rejintal and Aswini.N, 2016) and in AML screening systems (Agaian et al., 2014). K-means clustering does not give classification with labelled data and also not applicable on incremental data (Vaghela et al., 2015).

8) Morphological Operations (shape-based): Segmentation using morphological operations is a technique considering the processing of geometrical structure based on set hypothesis, topology, lattice hypothesis and arbitrary functions etc. This is the most successful segmentation method that has been used so far. Through this method it is very easy for detecting white cells, overlapping of cells and shape of cells. Thus this is based on statistics so can get approximate results.

Bhattacharjee and Saini (Bhattacharjee and Saini, 2015), Vaghela and the group (Vaghela et al., 2015) and Raje and Rangole (Raje and Rangole, 2014) are some researchers who have used morphological based image segmentation in leukemia diagnosis. They have discovered that the morphological operators used for the extraction of features have resulted in high segmentation accuracy. Segmentation using morphological operations has been used in morphological classification of Leucocytes by microscopic images (Scotti, 2005; Piuri and Scotti, 2004). There, the researchers have focused on reducing the problem of identification and classification of WBC types in microscope images using morphological operations.

## B. Classification Methods

Classification is in charge of assigning to the unknown test vector which is a label from one of the known classes (Rege and Dr.Gawli, 2015). Mostly used classifiers are as follows.

1) Support Vector Machine (SVM): SVM is a discriminative classifier that is formally defined by a separating hyper plane. When labelled training data is given (supervised

learning), the algorithm outputs an optimal hyperplane which categorizes new examples. Patel and Mishra (Patel and Mishra, 2015) is a research group who presented an automatic approach for leukemia detection using microscopic images. Colour, geometric, shape and statistical features have been analysed and classified under the SVM classifier in the intention of grouping the normal and abnormal cells. SVM has been used to classify leukemia types too. A three-layered framework consists of feature extraction, coding, and classification for the detection of leukemia from blood smear images has been proposed by Faivdullah and his colleagues (Faivdullah et al., 2015) leukemia types. They have employed a one-vs-all technique to convert SVM, which is a binary classifier in to a multi-class classifier.

2) Artificial Neural Network (ANN): This is a statistical learning algorithm defined by an interconnected set of nodes that are similar to the network of neurons found in brain. ANNs are capable of pattern recognition and machine learning, thus is mainly used in generating and estimating the output from a large number of input data set (Bhattacharjee and Saini, 2015). Mohapatra and the colleagues (Mohapatra et al., 2012) have engaged in another project in Lymphocyte image segmentation using Functional Link Neural Architecture for ALL detection (Mohapatra et al., 2012). Fatma and Sharma (Fatma and Sharma, 2014) have tried on a system to identify and classify sub types of acute leukemia using neural network.

3) CART (Classification and Regression Trees): CART (Classification and Regression Trees) statistical method has been used in automatic leukemia diagnosis in investigating the classification power of cell markers extracted in segmentation (Serbouti et al., 1991). This method generates classification tree diagrams with complete splitting information at each node and then produces a classification matrix, splitting cost and probability matrix for both the learning sample and the cross validation. The classification trees can be saved and used in classifying unknown specimens. Serbouti and the research team has employed CART in their research done in automatic leukemia diagnosis (Serbouti et al., 1991).

4) K-Nearest Neighbour (KNN): This is considered to be the best classifier in the family of nonparametric method with a good scalability. In leukemia detection  $kNN=1$  is considered to classify between blast cells and normal lymphocytic cells (Bhattacharjee and Saini, 2015). Bhattacharjee and Saini (Bhattacharjee and Saini, 2015)

in their research in diagnosing ALL have discovered that KNN is the best classifier that produced high specificity and also have the lowest computational complexity which has produced a specificity of 95.23%.

5) Ensemble of Classifiers (EOC): Ensemble methods are machine learning algorithms that construct a set of classifiers and then classify new data points by taking a weighted vote of their predictions (Dietterich, 2011). EOC improves of the performance of individual classifiers. The ultimate goal of classification result integration algorithms is to generate more certain, precise and accurate system results. But EOC possess some limitations also such as increased storage, increase the number of computations and decreased comprehensibility. EOC is been an efficient classification model used in leukemia diagnosis so far. An ensemble classifier system for early diagnosis of ALL has been developed by Mohapatra and group in 2014 (Mohapatra et al., 2014). As the results they have obtained more accuracy in EOC in comparison with other classifiers employed. Scotti and Piuri (Piuri and Scotti, 2004) have used ensemble of classifiers on their research done in Morphological Classification of Blood Leucocytes by Microscope Images. The classification accuracy has been tested and a proper classifier has been chosen from a set of candidates of different classifiers.

### III. METHODOLOGY AND EXPERIMENTAL DESIGN

An automated Acute Lymphoblastic Leukemia diagnosing application would be a useful tool in diagnosing of Acute Lymphoblastic Leukemia in blood samples efficiently and accurately. The basic method for diagnosis can be divided into following steps.

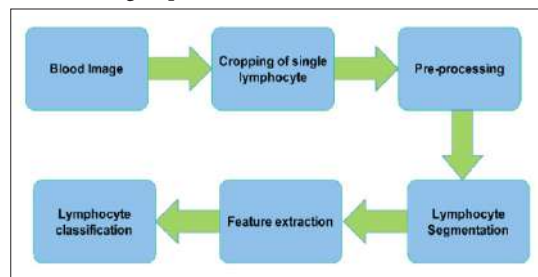
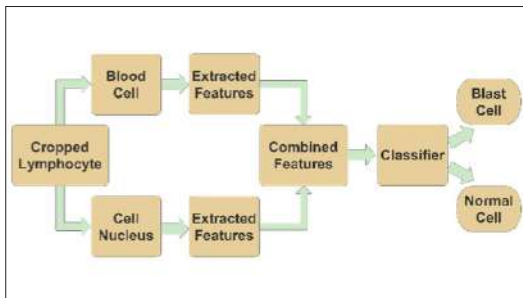


Figure 2. Basic diagram of the system

The input for the system is the Leishman’s stained blood slide image, and the lymphocytes in the image are cropped and individuated manually. Firstly in the pre-processing module, the image acquisition noise and background non-uniformities are removed. Secondly image segmentation is performed using a proper segmentation technique. This is done using three consecutive steps of background removal, separating the lymphocytic cell and separating the nucleus region which has been described in this paper. In the feature extraction module, various morphological features are been sorted differently using the segmented regions of the lymphocytic cell and the nucleus. Combining the features of both cell and nucleus, some new features are also calculated. In the lymphocyte classification module the tested cells are labelled as blast or normal.

**A. Image Acquisition**

The inputs for this automation process are microscopic images obtained from peripheral blood films which stained by Leishman’s that has been obtained from Department of Pathology Clinic at Faculty of Medicine, University of Colombo. All the obtained images are affected from B-ALL precursor which is a major type of ALL. The images are captured from two different camera sources as Huawei GR5 2017 smartphone camera and Canon camera in the same lightning conditions, resolution and magnification. The slides are placed under a MicroTech XSZ-N207 microscope in 100 magnification. 75 of the chosen images are taken into the experiment. Microscopic images acquired from the ALL-IDB (Acute Lymphoblastic Leukemia Image Database) are used as standard. 50 images chosen from ALL-IDB2 database are used.



**Figure 3. Block diagram of the proposed algorithm**

**B. Image pre-processing**

Pre-processing is essential as normal images consist of excessive staining and shadows. Image enhancement, which is used to bring out the image details that are obscured is the main task of this stage. Following three main tasks are performed in this stage.

- 1) Fast NIM eans Denoising Coloured technique: This is done to remove noise and excess blurriness.
- 2) Edge enhancement: Done in order to sharpen the image by cleaning the cell/cell segments in the boundary of the image.
- 3) RGB splitting: The RGB image is split in to three channels; green, red and blue in order to identify the red blood cells and white blood cells separately.
- 4) Removing the green channel: Green channels are mostly sensitive to red blood cells. Thus, it is removed from the image in this step.

**C. Image segmentation**

Segmentation process partitions an image to its constituent segments or objects known as pixels. This locates objects and boundaries (curves and lines etc.) of images and modifies the representation of an image into somewhat that is more meaningful and easier to analyse. This is a crucial step as the following feature extraction and classification results are much related with the result of the segmentation module. In this stage the following three steps are under gone.

- 1) Background removal: In this stage, canny filter is first used to reconstruct the border of the cells present in the image. Then morphological operation ‘dilation’ is done using a prepared structuring element. Then ‘closing’ is done. Combing the images obtained from dilation and closing, a new image is obtained. Next, threshold to Zero, Inverted thresholding is performed to the image obtained from pre-processing. Then the resulted image is combined with the new image obtained from morphological segmentation and the background is now removed.



2) Isolating the lymphocytic cell: In the resulted image, the largest contour area is considered to be the area of the cell region. The image is then subjected to a combination of binary thresholding and Otsu's thresholding and a binary image of the cell is produced. The total blood cell's binary image is now ready for feature extraction.

3) Isolating the nucleus: In this step, firstly the intensity of the original cropped blood image is increased such that only the nucleus will be visible in the image. Then thresholding is done in order to separate the nucleus. Here a combination of binary thresholding and Otsu's thresholding is done. Then the nucleus region is segmented by subjecting the image to the background removal step described earlier. Then the segmented nucleus is converted to binary and it is now ready for feature extraction.

**D. Feature extraction**

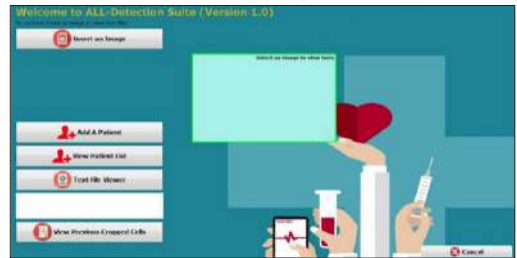
In feature extraction, the acquired data from the image is transformed and labelled to a particular set of features, which is going to be used for further classification. The binary equivalent images produced by the segmentation technique of blood cell and cell nucleus are used to extract those morphological features. Using the extracted features of blood cells and nucleus, some combined features also have been calculated. Some of the features that are explored are given below

**Table 1. Parameters Obtained In Feature Extraction**

Feature	Parameters Extracted
Colour features	Mean colour values
Geometric features	Perimeter, Radius, Area, Compactness, Rectangularity, Convexity, Symmetry, Concavity, Elongation, Eccentricity, Solidity etc.
Texture features	Entropy, Energy, Correlation, Homogeneity etc.
Statistical features	Skewness, Variance, Mean, Gradient matrix etc.

**E. Image classification**

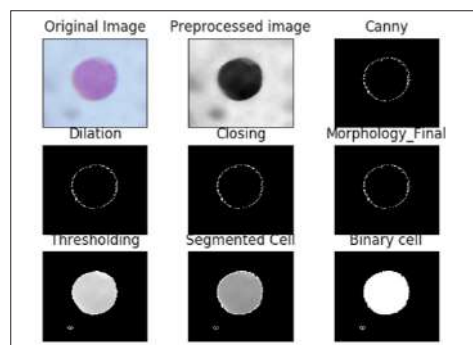
For classification, K-Nearest Neighbour classifier is used



**Figure 4. ALL Diagnosing Window**

**IV. RESULTS**

There are two main objectives that this research is focused on. One is to develop an algorithm to compare the image qualities of purely isolated cells and overlapping cells. Second one is to detect the quality devastation in blood films in terms of storing them for prolonged period. The proposed algorithm was implemented using python programming language using the OpenCV package for python. Following figures depicts a design of user interface and the results that were obtained in the segmentation, feature extraction and classification stages separately.



**Figure 5. Segmentation results of the cell**

Figure 5 elaborates the results of a lymphocyte image used for segmentation stage of the cell. In the figure firstly, original image is shown. The pre-processed image shows the result of the steps FastNlMeansDenoisingColoured technique, Edge enhancement, RGB Splitting and removing the green channel respectively. Next canny, dilation, closing and combination of dilated and closed images, thresholding for pre-processed image and binary image of the cell has been shown.

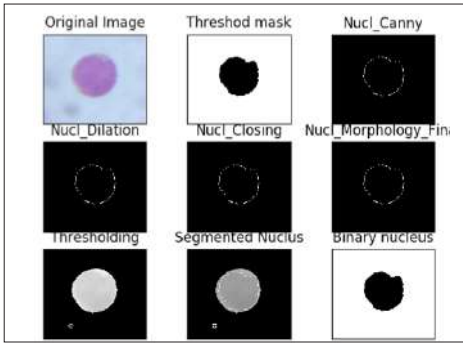


Figure 6. Segmentation results of the nucleus

Figure 6 elaborates the results of the same lymphocyte image used for segmentation stage of the nucleus. In the figure firstly, original image is shown. Then the thresholding mask image shows the result of the combination of the binary and Otsu's segmentation performed. Next canny, dilation, closing and combination of dilated and closed images, thresholding for pre-processed image and binary image of the cell has been shown.

In the feature extraction module, 12 geometric features with regard to the cell and nucleus had been extracted separately. The features extracted are area, perimeter, circularity, diameter, roundness, compactness, nucleus to cell ratio, cytoplasm area, cytoplasm to nucleus ratio, convexity and solidity. The features had been saved in a csv file. Those features extracted with respect to a one lymphocytic cell are depicted in Figure 7. In the classification stage, the features have been fed to the K-Nearest Neighbour classifier. Out of the 75 images used, 35 images have been used for the training the classifier and 40 for testing. The label 1 has been outputted for detected acute leukemic cells and label 0 has been outputted for healthy cells respectively as shown in Figure 7.

```

Name: File
C:\Python34\python.exe C:/Users/Deep/PycharmProjects/ALL2016/11a2.p
["nucl": 0.0, "nucl2": 0.0, "nucl3": 0.0, "nucl4": 0.0, "nucl5": 0.0, "m
Cell Features
Area: 2072.0
Perimeter: 375.260032439503
Circularity: 26504.285714285714
Solidity: 0.0
Roundness: 1.6282454.545454547
Compactness: 0.4833653138173646

["nucl": 0.0, "nucl2": 0.0, "nucl3": 0.0, "nucl4": 0.0, "nucl5": 0.0, "m
Nucleus Features
Area: 2072.0
Perimeter: 375.260032439503
Circularity: 26504.285714285714
Solidity: 0.0
Roundness: 1.6282454.545454547
Compactness: 0.4833653138173646
Form Factor: 0.8939393939393939
Nucleus to Cell Ratio: 0.99153019206213
Cytoplasm Area: -6.0
Cytoplasm to Nucleus Ratio: -346.4166666666667
Convexity: 2.901.0
Solidity: 0.710477076700443
[ 1459. 13709. ]
[ 3522.0 3066.0]
[ 3007.0 3943.0]
[ 4455. 3576. ]
[ 2849. 3755.0]
[ 7460.0 1472. ]
[ 3931.0 3227.5]
[ 8281.0 3203.0] ['1', '1', '0', '1', '1', '1', '1', '1', '1', '0']
The resulted class is: 0
    
```

Figure 6. Segmentation results of the nucleus

The proposed algorithm is been tested and developed to detect features of overlapping cells and to detect the quality devastation that occurs in old blood films when they are kept for 3-6 months.

## V. CONCLUSION AND FURTHER WORK

The developing system will be extended to have good results in automatic diagnosis of the disease in the acquired human blood samples. The proposed algorithm can also be further develop to detect the granules and intra cellular components inside the cell. As per the statistical data published in future spreading of a cancer like leukemia in the world, automation procedures to detect leukemia has become an urgent need. Governments, especially in a developing country like Sri Lanka would find these automatic leukemia detection systems as cost effective solutions to implement in hospitals.

### ACKNOWLEDGMENT

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# CONCEPTUAL APPROACH TOWARDS STATEFUL COMPUTATION OFFLOADING IN RESOURCE CONSTRAINT ANDROID DEVICES

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**Abstract** - Cyber Foraging is an approach to resolve the performance and resource limitations of small portable hand-held devices, through offloading heavy processes to nearby stationary devices called Surrogate Devices, which have more computation capabilities. The way the Cyber Foraging is mostly tackled by invoking a remote method in the Surrogate Device – which contains the application related information as a pre-requisite – at the time of local invocation, in a state-less manner. This limits the possibilities where the Cyber Foraging can be used in state-full context, which can provide maintenance of state which will help the developer to transmit state of objects used inside the offload candidate so it won't differ from local execution and remote execution. In order to use in a stateful manner, researchers have used a virtualisation approach, which is a resource consuming approach. As an alternative, we propose a conceptual solution to transmit state from mobile platform to the surrogate platform, without having to deploy a mobile OS virtual machine into the surrogate environment. The concept will address all the drawbacks of virtualisation and provide the similar benefits at a lower resource cost in the Surrogate end.

**Keywords** - Cyber Foraging, Distributed Computing, State-full Offloading

## I. INTRODUCTION

This section gives a brief background to the domain cyber foraging, specifying the problem we are focusing on and the motivation towards proposing a conceptual approach towards stateful computation offloading and the methodology used for the research. Followed by existing work, proposed approaches, limitations, conclusions and future work.

### a. Background

1) Cyber Foraging: Since then there has been various attempts to fulfil Mark Weiser's vision (Weiser, 1991); however, these mobile devices are coupled with some limitations like limited processing power and battery standby. Cyber Foraging, which was a term coined by M. Satyanarayanan, is an attempt to offload process from a portable resource constraint platforms of mobile devices to a stationary resource rich platform, called a surrogate. Following his approach there have been various attempts towards a perfect cyber foraging solution, which is both efficient and developer friendly.

2) Offloading Approaches used in Cyber Foraging and their Limitations: There are two computation offloading approaches available for cyber foraging: 1) State-less computation offloading and 2) State-full computation offloading.

State-less offloading is where the surrogate is not aware of the state of the application or objects in the heap memory. Surrogate will execute the offloaded method in a method level where the parameters are passed and method will be executed in a static context. Most of the cyber foraging approaches do not maintain state during the offload, as a consequence granularity of the off loadable component is limited to the method.

There are only very few significant approaches, which support state-full offloading. They use virtualisation, where the mobile operating system is replicated in a remote location and the mobile device and the surrogate share the application state among each other, which is costly on the surrogate end, making it unattractive towards the surrogate owner. This also creates a dependency between surrogate and the mobile device.

In order to avoid these adverse impacts, we propose a state-full offloading approach, which does not create unnecessary dependencies and does not involve Virtualisation.

### b. Methodology

The existing approaches and their specifications were identified from a literature survey. Almost 57 preliminary researches has been conducted in the domain of enabling cyber foraging (Lewis & Lago, 2015). The survey published by Lewis & Lago covers majority of the approaches at the time of their writing. It was helpful in revisiting the approaches, and also recent approaches had been surveyed and considered within the scope of this research.

We took the liberty of referring our previous work in the domain, targeting towards a better practical solution into consideration, as empirical research. We had experimented with a state-less architecture, and we are currently focusing on supporting state-full offloading without virtualisation, which was one of the major limitation addressed in our earlier proposed architecture. (P Vekneswaran, 2016)

## II. EXISTING WORK

Even though there are significant amount of researches done in the domain, there is only a handful of approaches that maintains state while offloading; and all of them are virtualisation based solutions where maintaining the state is vital to react upon each invocation.

### a. AMCO

The mobile application developer declaratively specifies the suspected energy consumption hotspots in a mobile application. Based on this input, AMCO then automatically transforms the application to enable it to offload parts of its functionality to the cloud. The offloading is exceedingly versatile, being driven by a runtime framework that powerfully decides both the state-to-offload and its exchange instrument in light of the execution condition set up. In addition, the system continuously improves with a feedback-loop mechanism.

To mark hotspot components, AMCO provides a Java annotation `@OffloadingCandidate`; this information can also be specified through an XML configuration file. Based on this input, an analysis engine first checks whether the specified component can be offloaded as well as any of its sub-components (i.e. successors in the call graph). The engine additionally ascertains the program state, to be exchanged between the remote and local segments that would should be exchanged to offload the execution of both the whole segment or of any of its sub-segments. A bytecode enhancer at that point creates the checkpoints that spare and re-establish the ascertained state for the whole hotspot segments and additionally for each of its subcomponents (Kwon & Tilevich, 2013).

It is easier to develop cyber foraging enabled application on top of AMCO because it is just a matter of annotating the offload candidates or migrating the entire processes to the cloud. But it also adverse impacts such as cost of sharing the entire state, tracking state modifications also offloading everything to the could not be beneficial at all times.

### b. ROAM

ROAM is a JAVA application framework that can assist developers to build Java Based multi-platform applications, which run on heterogeneous devices; and allows a user to move/migrate a running application among heterogeneous devices without any significant effort by the user.

In nutshell, the ROAM agent on the source device first negotiates with the ROAM agent on the target device. The negotiation involves exchanges of the target device capabilities needed by each application component, and the code base URL where the ROAMlet component byte code can be downloaded from. Based on the exchanged

information, the ROAM agent decides the appropriate adaptation strategy for each component. The ROAM agent on the target device downloads the necessary ROAMlet class byte code from the HTTP server for all application components that will be instantiated on the target device. The ROAMlet on the source device serializes its execution state and sends it to the ROAM agent on the target device. The ROAM agent may perform execution state transformation if an application component is transformed or dynamically instantiated. The ROAM agent instantiates the ROAMlet on the target device. (Hao-hua Chu, 2003)

ROAM doesn't target computational offloading directly but does focus on task migration aspect in depth. What ROAM is trying to achieve is pretty far fetch because it is attempting to tackle pervasive computing first rather than Cyber Foraging itself. Server components must be manually written so according to the device context the code/service will be retrieved from the server. Even though it mentions about the heterogeneous devices, they are targeting Java based operating systems all run on JVM. So, transforming state is straight forward.

### C. Clone-Cloud and Cloudlet

Cloud computing alludes to a style of figuring where online assets and applications are accessed by clients through a web browser, yet the real software and data are put on remote servers. As the client's point of view, the client does not have to buy, oversee or maintain the technology "in the cloud". Intel's thought is to take the mobile device that has lower performance and clone the whole arrangement of information and applications onto the cloud, at that point sync the two. It is then likewise conceivable to dole out graphics and processing power to the task in the cloud and give an apparently elite with full PC-like experience to the present smartphone or netbook with no change to the client experience and interface. (Chun, Ihm, Maniatis, Naik, & Patti, 2011)

Clone-Cloud and Cloudlet approaches don't fall too far away from each other. Cloudlet is a concept to deploy an in-box cloud in house, which is self-managed and does not need any professional attention. A cloudlet is deployed for few users to share the computing resource via the high-speed LAN network, rather than using the distant public cloud on the Internet in order to shorten the latency for real time application.

Even though it's easier to develop just like AMCO, Clone-Cloud requires heavy modifications to the Android Device kernel to support this infrastructure.

### D. Collaborative Applications with Mobile Cloud

This contains an architecture and a paradigm for developing collaborative applications with minor modifications to today's mobile and cloud computing infrastructures. This approach is focusing on cloning the kernel requests and responses in the cloud to maintain state. Also has an offload advisor to evaluate the effectiveness of offloading and make the choice to offload or not. (Yu-Shuo Chang, 2012)

This also requires hosting and has the same drawbacks as of Clone Cloud and Cloudlet.

## III. PROPOSED APPROACH

In order to enable less developer effort in cyber foraging enabled mobile applications development, we think that the assistance provided by the development framework to the developers is an important fact. (P Vekneswaran, 2016) Aspects (JBoss, 2016) reduce the build process immensely, by reducing the need to write separate code for the off loadable components, which will be discussed in the following section. Also, we made improvements for achieving computation offloading, to support state transmission to other VMs.

### a. Aspect based Annotation

Candidate methods, the resource intensive components of the code, recommended for offloading can be scattered all over the application, thus the application has to invoke the decision-making engine every time before such method is invoked. Knowledge of those offload method calls is simply irrelevant to the business logic in the class. In such scenario, we propose to use Aspect Orientation in mobile application code, to identify the compute intensive tasks all around the application, and while using annotations won't interfere with the business logic or the object orientated design and architecture of the application. (P Vekneswaran, 2016)

The annotation is the key of our proposed approach, which helps the developer to specify the identified intense tasks in the application to state, which affects the execution. In

this approach, there are already predefined advices, which need to be injected during the compilation phase. Here the advice is the code that is injected into the class file; typically, which needs to be inserted before, after, or instead of the target method. When the method is marked using the “offloadMethod” annotation, AspectJ will generate the boilerplates that is necessary for the annotated method.

In our approach, we suggest annotating the potential offloading candidate methods in classes, using the “offloadMethod” along with the name of the objects which states need to be transferred to the Surrogate using Aspect orientation. Just using one annotation, identifying different methods with different behaviours is not possible. Therefore, it is necessary to be able to annotate a single method using multiple annotations as a part of the framework we propose; so, the developer can create his custom defined aspects through creating new annotation interfaces using default templates provided.

#### **b. Development Process and Limitations**

When using the annotations, the developer should identify the methods and objects that is referenced inside the context that consists of the compute intensive components that has be considered by the decision-making engine during the runtime, weather it needs to be offloaded or not. This requires the developer to have a basic knowledge of the application source, states of the objects that is required for offloading, and the flow of execution.

Identified intensive methods cannot reside inside Android Activities. These methods should not attempt to read hardware specific sensor data inside their scope, which will cause errors during the runtime. Alternative is to read the sensory data and pass it as a state. The intensive components should be added to a separate java class for it to be executed correctly in the surrogate environment. If the source is already separated this step can be ignored.

These candidate methods should be marked by the developer by adding annotations along with the object details, which the state needs to be preserved. During the build time boilerplate codes will be added by the AspectJ runtime, which is included in the framework. There are predefined aspects, which the developer can use, or if the developer is looking for some distinct characteristics, he can modify the aspects accordingly. Afterwards developer can build the application and produce the APK, which is ready to be installed in the mobile devices.

The surrogate service should be running at the time when the application is about to execute the compute intensive tasks. According to configuration, the mobile application will find the surrogate device and attempt to connect to the service and offload. The surrogate service will then check if the mobile application is already in its repository of packages. If not, it will pull the source from the mobile device. As the components are sent automatically to the surrogate, there is no need for the developer to manually deploy the components explicitly. This is a one-time process, and afterwards any mobile device running the similar application can offload to that particular surrogate device, without pulling the source to the surrogate. Once the source is loaded, the surrogate will execute the task copying the objects and their states to its heap and return the result back to the mobile device with the updated heap state. If it is not beneficial to offload, the mobile device will execute the task normally without offloading to the surrogate.

## **IV. EVALUATION**

The proposed solution will have the following advantages over the existing development approaches.

It eliminates the need for writing two separate codes to do the same task in the mobile and surrogate to preserve state, or use virtualisation as an alternative to enable cyber foraging in new applications. Also, no need to modify the existing source code, just need to annotate the offload candidate methods and meta information required to process the information. This will cut down the time required by the developer to enable cyber foraging in mobile applications. The Aspect based approach will allow the developer to plug and play his own logic in the decision-making engine, communication protocol etc. according to his requirements giving him/her full freedom to customize the outcome. When building the application, the AspectJ runtime will handle the generation of the necessary boilerplate codes, which will further cut down the developer cost. In comparison to the existing approaches that is discussed in Section 3, the proposed solution in this paper has majority of the development process automated and easily configurable through the build scripts. This approach will also give developers, enough customisation options as well. Also without hosting the entire mobile operating system the lightweight service will compute the JAVA components.



## V. CONCLUSION AND FUTURE WORK

Even though cyber foraging can be easily achieved through virtualization, there are other factors such as functional overhead, which have adverse impact on the energy consumption and performance. We can conclude that the offload technique we propose is more effective in a preliminary level, and reducing the time consumption for the development by automating most of the build process with the help of AspectJ and Android Development Environment. At the moment doesn't support non-java based platforms. Also, it will not support rapid state changes at the moment.

We expect to further improve the proposed approach and introduce a framework, allowing more common features like integration to the available IDEs, which will reduce the developer effort furthermore, supporting rapid development. Future of this research will extend to supporting the android code such as activities, fragments rather than being only able to offload the JAVA components of the application.

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# TOWARDS EMAIL-BASED WORKFLOW AUTOMATION

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**Abstract** - Modern day organisations and individuals use emails as a communication media and there exist workflows correlated to the email communication such as responding, forwarding and more complex workflows such as content analysis and attachment handling. These workflows are highly user-dependent due to various requirements such as uniqueness of users' fields of occupation. There exist commercial tools, which are explicitly designed to fulfil the purpose of email based workflow automation and management; however, these tools are associated with email marketing campaign management thus, providing a set of marketing-centric features. If we can understand the diverse requirements of the users, it may help in providing a better solution towards effective email based workflow automation. Having analysed aforementioned limitations of prevailing tools, we conducted a survey towards understanding the requirements of the users well, towards suggesting an email-based workflow automation system. We expect to utilize this knowledge to develop a more customizable solution to satisfy the diverse user requirements via enhanced decision-making abilities.

**Keywords** - Email, User requirements, Survey, Workflows, Workflow Automation

## I. INTRODUCTION

There exist several email workflow automation tools and Platforms, which have different capabilities of automating processes related to email communication. The majority

of these applications are designed to be marketing-centric thus, providing a set of features, which are highly converged towards email marketing campaign management and automation. This itself is a limitation of those platforms since they are not suitable for prevailing association with non-marketing intentions. Even though a few of the aforementioned platforms such as GSuite (Google 2016) and IFTTT (IFTTT Inc. 2016) look promising towards customisable email-based workflow automation, there are certain limitations, which possibly obstruct the usage of them.

Platforms like GSuite are more focused on the business process management even though it provides very preliminary features related to Email-based Workflows such as auto-responding and clustering Emails. The IFTTT platform has a comparatively larger number of automation options in that case. IFTTT's keyword-based automation is a fundamental decision-making technique, which has less flexibility towards handling complex scenarios such as when there are multiple criteria affecting an automation-related decision.

The actual user requirements can be much complex and diverse; therefore, the available platforms may not cater the features to fulfil them. When user requirements for automation are complex unlike a simple keyword-based condition and vary due to various reasons such as user's field of occupation, the complexity of the automated workflow increases. Therefore, enhanced decision-making abilities and customizability to handle various user

requirements are needed to satisfy the diversity of the user requirements. In the direction of doing so, it is important to understand the nature of actual user requirements and the limitations of available solutions.

We conducted a cross-sectional survey to derive a sound understanding of the user requirements in the context of the email-based workflows and the automation of them by organising and structuring them in a systematic way. This study contains results and the analysis of the cross-sectional survey carried out among the target audience. Then we review the existing work with the context of the identified requirements.

The methodology followed in this study is given in section II. Section III provides the background of the problem domain along with related subject domains, discussed in detail to provide an overall understanding of the problem addressed by this study. After that, in section IV the results and the analysis of the cross-sectional survey is presented in detail. Section V reviews the existing work within the context of the analysis stated in the previous section. Finally, the study is concluded with an explanation of the conclusions derived, and also specifying the future work.

## II. METHODOLOGY

The methodology used for the survey is specified under two sections: Literature survey and cross sectional survey.

### a. Literature survey

The identified domains related to this study are workflows, workflow management and automation, email communication, and decision making concepts. Literature in aforementioned domains was identified and critically analysed through a Literature Survey. It was conducted to derive an understanding of the background of the study, the approaches, which have been already proposed and have been implemented by researchers, and to understand the potential, which existing solutions hold towards fulfilling the needs related to the email based workflow automation.

There was a considerable amount of research papers related to the domains of this study found on the internet libraries. Google Scholar was the primary search engine used to search for academic publications available on the internet and, IEEE Explore Library was used to download conference and journal publications related to domains.

The knowledge gained is utilised in discussing the background in section III and existing work in section V.

### b. Cross-sectional Survey

The target population for the cross-sectional survey was the general public who are using emails and involved in several fields of occupation. The survey was carried out in the form of an online questionnaire designed and published using Google Forms. The online questionnaire was sent to known contacts via social media websites (Facebook and Twitter) and was also sent to a randomly selected set of email addresses, which were gathered from colleagues working in different industries. The 'Simple Random Sampling technique' was used to select 63 candidates out of total 70 responses, which were collected within a period of 14 days. The Successful Response Rate (SRR) of the survey can be calculated using the equation (1).

$$SRR = \left( \frac{\text{Surveys Completed}}{\text{Total of Surveys Started}} \right) * 100\% \quad (1)$$

$$SRR = \left( \frac{63}{70} \right) * 100\% = 90\%$$

The calculated successful response rate suggests that the survey was successful.

The gathered data was exported to an Excel spreadsheet using Google Sheets, and statistical information such as averages, percentages as well as graphical models such as charts were generated using Microsoft Excel's inbuilt formulas and wizards.

## III. BACKGROUND

This section discusses the background of the emails, workflows and workflow automation, and email based automation gained through the literature survey, to have a strong understanding towards designing the cross-sectional survey.

### a. Email Communication

Email or electronic mail communication has become a vital method of communication in the present day and many organisations, as well as individuals, use email to collaborate and share information (Zhang et al. 2006). The idea of Electronic Mail was originated in late 1960's (Gibbs 2016) and has currently emerged as a swift and reliable way

of communication, which operates through the internet. The email communication mechanism is based on the client-server architecture. In a typical scenario, an email will be sent to a server using a client application, and it will be forwarded to the corresponding recipient by the Email server. Originally, email messages were solely based on the ASCII text format and eventually was prolonged to use Multipurpose Internet Mail Extensions (MIME), which allowed to send multimedia content attached to messages and text character sets other than ASCII (Bonaventure n.d.). An email message has a simple anatomy. It consists of a header and a body. The body contains the content of the message, and the header contains various information which helps to encode and route the message across the network.

### **b. Workflows, Workflow Automation, and Management**

A workflow could be a single operation or a sequence of operations conducted by an individual, a group of people or an organisation (Georgakopoulos et al. 1995). In early days, processes in an organisation were solely controlled by humans who manipulated physical objects, and with the introduction of information technology, processes above were ported to information systems and also automated partially or entirely (Georgakopoulos et al. 1995). The notion of the automation and management of workflows was originated about three decades ago (Ploom et al. 2013), and it has been evolving throughout years. There are tools and platforms designed specifically for business workflow automation such as Xiaochun's Real Estate Office Automation System (Xiaochun 2009), Wu & Huang's COAS System (Wu & Huang 2011), and the Platform Based Automation System of Ploom et al. (2013). Also, there are many industry-level Business Process Management tools and platforms such as WSO2 Business Process Server (WSO2 n.d.), Sensus BPM (Sensus n.d.), ProcessGene BPM (Processgene n.d.), and KISSFLOW (KISSFLOW 2014). These tools are solely based on workflow management and automation and are specifically designed to deploy and utilise in a small to large-scale business environments.

As the Workflow Management Coalition (WfMC) (Workflow Management Coalition 1999) states, a workflow management system provides the automation of a business process by managing the array of activities. According to Lawrence, a workflow management system is a generic software tool which permits for the interpretation, execution, delegation and control of workflows (Lawrence 1997). Processes need to be initially captured to manage

them in a workflow management system, and each process needs to be understood with the cooperation of a human. This process is called 'Process Modelling', and it is a crucial part in the design of workflow management systems and has been pleaded by numerous authors using distinct approaches (Flores-Badillo & López-Mellado 2008). Repetto et. al and Dumas & Hofstede have used a UML-based modelling approach (Repetto et al. 2003; Dumas & Hofstede 2001), and Eyal & Haller have used applied temporal and transactional logics.

### **c. Email Automation**

The term 'email automation' fundamentally refers to the automation of business workflows related to emails. It involves the automation of sending corresponding emails to recipients based on factors such as time, customer engagements and statistical factors.

Email-based workflow automation systems such as Adobe Campaign (Adobe n.d.), Act-on's Marketing Platform (Act-on n.d.), Infusionsoft Automation Tool (Infusionsoft n.d.), and MailChimp (Mailchimp n.d.) are widely used in modern day business environments to fulfil their marketing needs. However, all the aforementioned Email automation tools are developed with a marketing-centric perspective; hence, making it a limitation of them since they cannot serve as a general automation tool, which can automate non-marketing workflows. However, there exists an insignificant number of platforms/tools, which are not marketing-centric and has the ability to fulfil the purpose of email-based workflow automation such as IFTTT (IFTTT Inc. 2016) and GSuite (Google 2016). These systems are reviewed in section V.

## **IV. RESULTS OF THE CROSS-SECTIONAL SURVEY**

The fundamental goal of conducting a data survey was to obtain an overall understanding of the usage of email communication among the target audience as well as to identify associated email-related workflows. It was needed to gather data from a variety of fields of occupations to derive a thorough understanding of the diversity of user requirements in the context of workflow automation. Another goal of conducting the survey was to verify the need for an automation system for email-based workflows by examining the usage of existing automation systems among the target audience.

1) Field of Occupation: A question was asked to identify the current field of occupation of the email users. The goal of asking this question was to understand the categorization of the email-related tasks/workflows based on their profession since the purpose of a task/workflow, which the user tend to automate would vastly vary based on their field of occupation. The responses as a percentage have been presented in Table 1.

The results reflect the distribution among the fields, which were defined hence, the identification of the variety of tasks/workflows based on the area of occupation is achieved.

**Table 1. Field of occupation of the respondent**

Field of Occupation	Percentage
Legal Occupations	1.60%
Education, Training, and Library Occupations	24.60%
Architecture and Engineering Occupations	24.60%
Business and Financial Operations, Sales and Related Occupations	19.70%
Arts, Design, Entertainment, Sports and Media Occupations	1.60%
Management, Office and Administrative Support Occupations	19.70%
Other	8.20%

2) Employed Department of respondents: A question was included to identify the section of the organisation, which the respondent is contributing. The aim was to categorise the tasks/workflows based on the section a respondent belongs to in an organisation. Figure 2 reflects the results as percentages.

**Table 2. The Department of the organisation, which the respondent belongs to**

Department	Percentage
Accounting	4.90%
Administrative	3.30%
Customer Service	9.80%
Engineering	18%
Marketing	16.40%
Operations	6.60%
Human Resources	8.20%
Sales	8.20%
Legal	3.30%
IT	34.40%
Other	4.90%

As results reflect, the most significant department, which has a higher usage of emails is the IT Department. The possible cause for that will be because the survey was distributed mostly among people who are working in the IT field.

Above two questions share a common goal, which is the categorisation of the workflows based on users' role in an organisational environment. These results affect the customizability of the system since the workflows, which are to be automated by it vastly vary based on the users' requirements.

3) Average time spent on emails: A question was asked to derive an idea of the average time a respondent spend on reading and writing emails.

**Table 3. The amount of time a respondent spends on reading and writing emails on a regular work day**

Duration	Percentage
About an hour	34.40%
From 2 to 3 hours	14.80%
From 4 to 6 hours	6.60%
More than 6 hours	8.20%

The results shown in Table 3 reflects that the majority of the users spend around an hour, and also a considerable percentage (~30%) of the users spend more than two hours per day. Spending hours on processing emails affects the productivity of an employee in a greater way, and that justifies the need for an automation tool/platform to automate portions of work.

4) The importance of email usage: The next question was asked to derive an idea of how important emails are in respondent's daily work. Table 4 shows the results of the responses.

**Table 4. The role of Emails for respondent's work duties and responsibilities**

Opinion	Percentage
Email makes me more effective. I can also use other communication methods	46.0%
Email is critical. I cannot operate at all without Email	46.0%
Email is optional. I mainly use other communication methods (chat, phone, fax, personal assistant)	7%
Other (Different Opinions)	1.60%

The results clearly reflect that the communication through emails plays a vital role for those surveyed day-to-day work responsibilities and obligations for the majority of respondents hence, supports the proposal of the automation system to be based on emails.

5) Respondent Opinion: The final question was to get the respondent’s opinion about the need for a system as proposed and the results are shown in Figure 5 reflects that there is a clear necessity for an automation system for email based workflows.

**Table 5. Respondent’s opinion about the necessity of the proposed system**

Opinion	Percentage
Yes	83.60%
No	16.40%

Ultimately, the respondents were asked, which workflows related to emails would they like to automate and the responses were summarised as follows.

1. Classification of emails (complaint/issue/informative)
2. Identify instructions in the email body
3. Drafting documents based on the content
4. Summarising the content
5. Categorising emails into folders
6. Update systems based on the email content (system configuration through email)
7. Scheduling appointments, calendar entries based on the content
8. Saving attachments
9. Notify others based on the content
10. Prioritise emails
11. Keyword-triggered actions
12. Send generic replies based on the email type
13. Predict the response

## V. EXISTING WORK

This section contains a review of the similar work identified in the Literature Survey. Approaches, which are related to workflow automation and management, as well as Email Automation and Management, are succinctly discussed in this section to derive an understanding of pros and cons of both traditional and modern trends in the domain of Workflow Automation.

Criteria to review existing work were identified after the analysis of the data gathered through the cross-sectional survey. The criteria were selected based on user requirements identified, and existing work will be comparatively reviewed against them. The criteria are as follows.

**Criterion A** - The support for email-based workflows is a key factor, which needs to be fulfilled by the reviewed approaches.

**Criterion B** - The customizability towards user requirements is an essential factor since the vividness of them was high a identified through the survey.

**Criterion C** - The extensibility is another key factor, which needs to be satisfied by existing approaches up to a great extent. Complex workflows such as classification of emails and email content analysis, which were identified through the survey suggest that the automation approach should be able to integrate with external tools and platforms.

**Criterion D** - The usability of the system is an essential factor since it is prominent to have a learning curve, which is not steep for the user since it could affect the productivity of an individual or an organisation.

**Criterion E** - The deployment and maintenance cost plays a major role in any system. As identified through the survey, the automation system should be able to cater single users as well as large-scale organisations.

### A. Workflow Automation and Management Approaches

This section describes existing workflow management and automation approaches, which are not limited to email-based workflows but also to other business processes such as assembly line processes, quality assurance processes and maintenance processes.

1) Xiaochun (2009): Xiaochun proposes a Workflow Automation and Management System for Real Estate Office Automation. He proposes a system to automate the execution of Business Processes through different Departments of the office. The implementation model based on email transmission involves the processing of workflows based on person-to-person email communication. The disadvantages he mentions are the dynamic nature of these sorts of workflows and the

difficulties of grasping them. He further implies that the difficulty to achieve automation of these types of workflows because of reasons such as the concentration of archiving and the high network traffic caused. He implies that the use of such a system does not suit for small scale Office Automation because of the higher development cost, the complexity of the implementation and the maintenance difficulties of the system.

2) Wu & Huang (2011): Wu & Huang (2011) propose a design for Office Automation Systems based on Workflows. The Company Office Automation System (COAS) they propose is a framework which manages data about the uniformity of resources in the office using a centralised database.

## B. Email Automation Tools and Platforms

This section discusses existing approaches which are designed for email campaign management and automation as well as general automation tools which can be utilised to automate email-based workflows.

1) IFTTT: 'IF This Then That' is a web platform which provides automation capabilities across various online services such as Gmail, Google Drive, Social Media websites and even IoT Device Management Platforms. IFTTT uses a concept called 'Recipes' to automate workflows by connecting two web services. A Recipe is simply a rule which consists of a trigger and a corresponding action, and the trigger always being a specific keyword. This platform can be used to automate Workflows related to Emails by connecting an Email provider such as Gmail to any other supported online service. However, this platform can only connect two services at a time using a Recipe, and it is limited to only a supported number of services.

2) MailChimp: This platform is designed specifically for Email Marketing Campaign Automation and Management and can integrate with a variety of other web-based services such as Google Analytics and Salesforce. MailChimp provides a significant number of pre-defined Email templates which can be used to design Email messages based on user requirements. MailChimp also provides Marketing Automation features such as auto-responders, periodic reminders and category-based follow-ups.

3) Adobe Campaign: This service is a portion of the Adobe Marketing Cloud and provides a large number of Marketing Automation Solutions. Adobe Campaign is a highly scalable platform and provides dynamic interfaces for real-time user interactions.

4) GSuite: GSuite is a collection of apps provided by the Google cloud platform. The apps include Gmail, Google Docs, Google Calendar and Google Drive and the platform provides the ability to connect them to form and automate business workflows. However, this platform is limited to the aforementioned applications hence, lacks the customizability.

A contextual comparison of existing approaches against identified criteria is presented in Table 6. The meanings of the notation used are as follows.

- (-) - Low
- (-+) - Medium
- (+) - High
- NA - Not Applicable

## VI. CONCLUSION AND FUTURE WORK

This paper has presented an overall study on subject domains of workflow automation, email usage among the general public and email-based workflow automation. Data gathered from the conducted data survey reflected the vividness and complexity of email-related workflows and supported the necessity of an email-based workflow automation system, which has more customizability with enhanced decision-making abilities was essential.

Existing approaches related to workflow and email automation were reviewed and contextually compared based on criteria: the support for email-based workflows, customizability, extensibility, usability and the cost.

**Table 6. Contextual comparison of existing workflow automation approaches**

	Xiaochun (2009)	Wu & Huang (2011)	IFTTT	Mailchimp	Adobe Campaign	GSuite
Criterion A	-+	-	+	+	+	+
Criterion B	-	-	-+	-+	-+	-
Criterion C	-	-	-+	-	-	-
Criterion D	NA	NA	+	+	-+	-+
Criterion E	+	+	-	-	-+	-+

The review along with the survey revealed that there exists no email-based workflow automation system, which has enough customizability to tackle personalised user requirements and, which fulfils the aforementioned criteria up to a satisfactory level. It was further identified that existing systems lacks decision-making abilities, which could handle sophisticated automation scenarios. We anticipate utilising the knowledge gained through this paper to introduce an email-based workflow automation system, which provides more customizability towards user requirements and has enhanced decision-making capabilities.

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# AUTOMATED GARBAGE COLLECTION ALERT SYSTEM

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**Abstract** - Waste collection has become one of the major issue in today's world. In a country like Sri Lanka there are no proper facilities for final disposal produced by households and industries. And also, relevant authorities do not pay much attention to this matter. There are different types of waste collection and management methods all around the world. But in Sri Lanka there is no proper computer based waste collection system has been developed yet. In this study a methodology for the optimization of the waste collection and transport system, based on Geographic Information System (GIS) was developed in this system, we introduce a mobile application to manage garbage in various areas. Through this mobile application, we can direct connect to the Municipal Council and inform the exact location of the garbage dump. In this system, we mainly focus on garbage dumps in the streets and main roads. By using this mobile application both people and municipal council can save time and extra money that they spend to collect waste in country like Sri Lanka.

**Keywords** - GIS, Solid waste disposal, Location tracking

## I. INTRODUCTION

With the increase in population garbage has become one of the major problem in a country like Sri Lanka. There are no proper way to disposal the garbage in our country. So people used to put garbage beside the roads. Daily life in countries like Sri Lanka can generate several kilograms of

solid waste from houses, factories, companies and various places. And with the development of Sri Lanka people are moving to cities for their own benefits, so that the amount of garbage increasing day by day. Because of these reasons garbage problem has become a huge problem for people.

There are different types of waste collection and management methods all around the world. But in Sri Lanka there is no proper computer based waste collection system has been developed yet.

So in this project we decided to implement a mobile application to develop a computer based garbage collection system. Using Information & communication technology this problem can solve successfully and also improve the environment friendliness. By using this "CleanUp" mobile application anyone can inform the locations of garbage dumps.

Anyone can this mobile application from anywhere by typing their name and their mobile number. And then he/she can track the garbage location and send it to the nearest municipal council. Then user will get a confirm message whether the tracked location and other information's (date and time, username, user mobile number) are send or not to the municipal council.

### A. Objectives

With the aim of developing an Automated Garbage Collection Alert System, we have identified the following objectives.

- To critically study the current issues in garbage collection in Sri Lanka
- To critically study the existing computer based solution for garbage collection
- To do a study software engineering life cycle
- To conduct a detailed study on current mobile applications, database and web technologies
- To develop a prototype for the system
- Design and develop Automated Garbage Collection Alert System
- Evaluate the new Automated Garbage Collection Alert System

### B. Hypothesis

One of the major issue that we are facing today is garbage collection. The methods that we are using to collect garbage today in Sri Lanka is not effective. And there is no proper Information Communication and Technology (ICT) based system to solve this matter. Technology has become a very important thing to our day today life and it is beginning to reshape our standard way of living. Internet is one of the information resources that today people are used. People save a lot of time and cash and find the information by giving little effort within the comfort of the home. In near future Information and Communication technologies (ICTs) will apply directly to urban problems to enable safer, healthier cities. The hypothesis for the creating CleanApp mobile application is to develop a computer based garbage collection system. In this system we mainly focus on to remove the the garbage that collect beside roads. Using Information & communication technology this problem can solve successfully and also improve the environment friendliness.

### C. Software solution for Garbage Collection Alert System

The solution of the Garbage collection alert system it is necessary to use new technological methodology for the system. According to that requirement system has developed by using C# and using SQL database to run on windows operating system. The mobile application has developed by using Java and Android studio.

### D.Resource Requirements

- The mobile application would develop as it is compatible with any other mobile phones which runs android, IOS and windows.
- The web server will be developed as it is compatible with any computer which runs Windows 7, Windows 8.1 and Windows 10.
- The mobile application will be implement by using Java and the android studio.
- The administrative interface will be developing by using the C# language with ASP.net framework.
- The database will be implement by using db forge studio for SQL server

## II. LITERATURE REVIEW

Through the review, it will be thought about regarding the procedure and available practices in automated garbage collection

[1] Jose M. Gutierrez et al (2015) has presented a waste collection solution based on providing intelligence to trashcans, by using an IOT prototype embedded with sensors, which can read, collect, and transmit trash volume data over the Internet. They have described how an integrated cyber physical system design, based on the combination of different disciplines in engineering, and taking advantage of municipal wireless access networks can lead to smart ways of improving the management of cities

[2] Adebayo P. Idowu et al. (2012) has developed a web based GIS waste disposal management system with the aim of achieving an effective waste management system and a spatial view of waste collection locations in any local government are in Nigeria. With this waste management system, the location of all the waste collection tanks in any location will be, monitored, managed and maintained. The use of this system will ease the job of the waste management unit of the local government areas in Nigeria in achieving a clean environment and mitigate the spread of epidemic in a way to ensure safety of all and sundry.

[3] Ashish Sam Geo, et al., have developed a new approach for a systematic development in managing solid waste. Garbage location is identified by using the GPS device installed and the coordinates are send to the corresponding mobile with GPRS module.

In this system, they have focused on to develop an electronic monitoring system for solid waste management. The system will have the facility to send SMS to the workers and supervisors. To develop a web based GUI so that the system can be accessed from anywhere and information can be viewed by different group of people.

### III. METHODOLOGY AND EXPERIMENTAL DESIGN

#### A. Approach

In the Garbage collection alert system process first user should login to the Mobile application by providing user's name and phone number to the system. Then the mobile application will track the coordinates (longitude and latitude) of the location where user is in (where the garbage dump is located). Then those information; User name, User mobile Number, Date and time and coordinates of the tracked garbage dump will send to the web server that is located in Municipal Council. After taking the information from the mobile application those details will be displayed on the municipal council's web server. The location of the garbage will be display on a map according to the coordinates that sent from the mobile application. Then the assign people will be send to that particular places to collect that garbage. And the web application will send a notification for the user whether the information send successfully or not and give a compliment for the sender for his service Each information that users send will stores in SQL server database successfully and for the work with the application it required continuous internet connection.

#### B. Technology Adopted

It is very important to use acceptable tools so as to develop productive system. Use on any inappropriate tools can solely ends up in develop a system with unnecessary errors and faults and use of those badly chosen technologies additionally can ends up in crashed when the new system implementation. Badly chosen technologies which can be extremely advanced and complicated will enable manufacturing a system with a top quality, however these technologies may result in develop a system that spend lots of time and resources so as to perform a task that is anticipated by the system. It is very important to use applicable programming language and the other necessary tools in order to develop a productive system. Therefore,

these technologies and tools can help to develop the system among a minimum development time the most objective of developing this type of an application is to produce the users more efficient work system instead of doing manual approach. Because of that we should use the most applicable tools available in the market to develop the system. Technological considerations - followed during the development of the system Efficiency and Performance Re-usability and flexibility object oriented development support so according to the Automated Garbage Collection Alert System java and android studio used to develop the mobile application. C# language is used, SQL Server 2012 as database for this project. This chapter includes the details about the technologies that we are going to use to develop Automated Garbage Collection Alert System.

#### Web Application

The programming language that is going to apply as the developing language for the system development turned into significantly trusted accuracy, performance. When considering all these technologies which can be associated with the Garbage collection system the proposed system can be applied a web based technology. The .NET Framework consists of the common language runtime and the .NET Framework class library. The common language runtime is the foundation of the .NET Framework. You can think of the runtime as an agent that manages code at execution time, providing core services such as memory management, thread management, while also enforcing strict type safety and other forms of code accuracy that promote security and robustness. In fact, the concept of code management is a fundamental principle of the runtime. Code that targets the runtime is known as managed code, while code that does not target the runtime is known as unmanaged code. The class library is a comprehensive, object-oriented collection of reusable types that you can use to develop applications ranging from traditional command-line or graphical user interface (GUI) applications to applications based on the latest innovations provided by ASP.NET, such as Web Forms and XML Web services. For example, ASP.NET hosts the runtime to provide a scalable, server-side environment for managed code. ASP.NET works directly with the runtime to enable ASP.NET applications and XML Web services. C# programs run on the .NET Framework, it runs on a virtual execution system called the common language runtime (CLR) and a combined set of class libraries. The CLR is the implementation by Microsoft of

the common language infrastructure (CLI) and it helps to create execution and development environments in which languages and libraries work together without any flaw. C# source code is compiled into an intermediate language (IL) that conforms to the CLI specification. The IL code and resources such as bitmaps and strings are stored on disk in an executable file called an assembly. Assembly is typically creating with an .exe or .dll extension. It contains a manifest that provides information about the assembly such as types, version, culture, and security requirements. When the C# program is executed the assembly is loaded into the CLR. Based on the information in the manifest CLR might take various. When the security requirements are met, the CLR performs just in time (JIT) compilation and convert the IL code to native machine code. CLR also provides other services such as automatic garbage collection, exception handling, and resource management. Following diagram illustrates the compile time and run-time relationships of C# source code files and the .NET Framework. The following illustration shows the relationship of the common language runtime and the class library to our applications and to the overall system. The illustration also shows how managed code operates within a larger architecture.



Figure 1. Interface of the web application

**Mobile Application**

Android gives you the freedom to put into effect your own device specifications and drivers. The hardware abstraction layer (Hal) presents a well-known approach for developing software hooks among the android platform stack and your hardware. The android working machine is likewise open source, so you can make a contribution your own interfaces and improvements. Android is an open source, Linux-based software stack created for a wide array of devices and form factors. The following diagram shows the major components of the Android platform.



Figure 2. Interface of the mobile app

**Android run time**

For gadgets going for walks android version 5. Zero (API level 21) or higher, every app runs in its very own technique and with its own instance of the android run time (artwork). Art is written to run multiple virtual machines on low-reminiscence devices by using executing DEX files, a byte code format designed especially for android that is optimized for minimum reminiscence footprint. Construct tool chains, including jack, assemble java resources into DEX byte code that can run at the android platform. A number of the predominant features of art encompass the subsequent in advance-of-time and just-in-time compilation optimized garbage collection higher debugging guide, such as a dedicated sampling profiler, exact diagnostic exceptions and crash reporting, and the capability to set watch points to screen particular fields previous to android model five.0 (API degree 21), dalvik was the android run time. In case your app runs well on artwork, then it need to work on dalvik as properly, however the opposite may not be real. Android additionally consists of a hard and fast of core run time libraries that offer most of the capability of the java programming language, which includes some java 8 language functions that the java API framework uses.

**Database Selection**

Consistent with the above eventualities most of the structures are used the square database to keep facts. It seems it is simple to control and perform. So, the database put in force on the server have to able to supplying efficiencies operations. Consequently, the proposed system decided on the Microsoft SQL server 2014 as server. SQL server is the inspiration of Microsoft's data base platform, delivering challenge critical performance with in-reminiscence technology and quicker insights on any

information, whether or not on-premises or in the cloud, and also Microsoft SQL Server is an application used to create computer databases for the Microsoft Windows family of server operating systems. Microsoft SQL Server provides an environment used to produce databases that can be accessed from workstations, the Internet, or other media too. Database management or DBMS, store user's data and enables them to transform the

25 | Page information into statistics. Those systems allow users to create, replace and extract facts from their database. A database is an established collection of information. Facts refer to the characteristics of human beings, things and activities. Square server stores every statistic item in its very own fields. In square server, the fields related to a particular character, thing or occasion are bundled collectively to shape a single complete unit of records, known as a document. Each record is made up of some of fields. No two fields in a record will have the equal area name. Throughout an SQL server database design project, the evaluation of your project wishes identifies all of the fields or attributes of interest. If your commercial enterprise desires trade through the years, you outline any extra fields or alternate the classification of present fields.

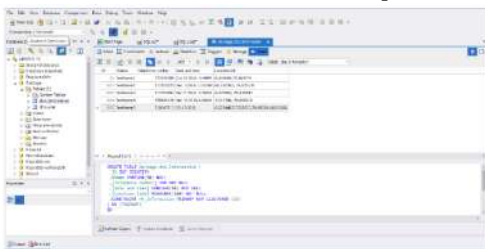


Figure 3. Interface of the Database

#### IV. EVALUATION

In this, we describe evaluation of our approach and the developed system while evaluating the objectives achieved how the project deviated from its original specifications and the circumstance identified during the time period of the project. This chapter will give the idea of the measure that have been taken to handle the problem occurred and knowledge which have been gathered by supplying solutions for such issues.

A formative evaluation a method for judging the worth of a program while the program activities are forming (in progress). This evaluation is done with the user requirements or the function requirements.

Summative evaluation refers to the assessment of participants where the focus is on the outcome of a program. It is done with a high-fidelity prototype to assess the achievement of product more progressive.

#### V. CONCLUSION

The results and outcomes generated in relative to the specificity of the problem domain are enlarged into wider concepts depending on logical assumptions. This chapter aims to clearly emphasize the outcomes and findings of the project and to determine way of these outcomes and findings can be matched in different contexts that are similar to the problems which are solved by the developed Garbage collection and alert system. In the rest of the chapter a total summary of the development of the system is given. Furthermore, future enhancements for the developed System have suggested finding out ways to give in addition features to the system and using it outside the business subject in use.

The aim of this project was to develop a Garbage collection alert system as a solution of disposal of garbage in Sri Lanka. The development team implemented this system in order to determine its ability to satisfy the entire functional and non-functional requirement with special qualities such as flexibility, reliability efficiency and etc., to overcome the drawbacks identified in the system. The study found out that it is feasible to use the language ASP.NET in C#, SQL Server 2012 as database and java in android studio used to develop the mobile application to develop the project.

It's a mobile application and web-enabled project so this mobile application offers user to install the application and enter data. This is very helpful for the user to enter the desired information through so much simplicity. The user is mainly more concerned about the validity of the data, whatever he is entering. In Web server admin provided the option of monitoring the records entered earlier. Data storage and retrieval will become faster and easier to maintain because data is stored in a systematic manner and in a database. Decision making process would be greatly enhanced because of faster processing of information since data collection from information available on computer takes much less time than manual system.

This system allows to get information about the garbage dumps in the relevant city. This gives efficient and cost effective. Mobile application can be access by defined

user categories by verifying their username and telephone number and web server can only be access by the admin by verifying the username and password. Client machines can be Windows xp, Windows 7, Windows 9 or Windows 10. Server computer should have operating system Windows xp, Windows 7, Windows 9 or Windows 10 and should be installed Visual Studio 2012, SQL Server 2012 and tool set.

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# NATIONAL FORENSIC DNA DATABASE MANAGEMENT SYSTEM FOR CRIMINAL INVESTIGATIONS

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**Abstract** - A DNA profile is a genetic fingerprint which is unique to each person and it is used as a powerful evidence to identify individuals in criminology. A DNA database holds DNA profiles taken from individuals and crime scenes and helps in quick identification of criminals that leads to improve the efficiency of the judiciary system of a country. The current process of using DNA evidence in court cases in Sri Lanka is more time consuming since the widely used electrophoresis gel image analysing technique requires expert scientists and often has human errors because of the anomalies that can occur in the faint gel images. Although there are novel advanced technologies and equipment based on capillary electrophoresis, the enormous cost of implementing and licensing them is unaffordable to third world developing countries like Sri Lanka. Therefore, this research paper proposes a fully automated and cost effective methodology to re-engineer the current manual process by integrating recent advancements in the computer science field such as image processing and machine learning techniques to spare human being from voluminous and tedious image analysing and to provide accuracy and rapid speed without human errors. The computerized system will get

the scanned electrophoresis gel image as the user input and it will enhance the quality of the gel image by using image processing techniques. After that it will generate the DNA profile and save it as a number pattern to the database for speedy retrieval. The system provides matches linking an individual to a crime scene or a crime scene to another crime scene. Furthermore, the system facilitates family relationship identification based on machine learning techniques. It ensures the security by integrating fingerprint authentication. Establishing a National Forensic DNA Database Management System in Sri Lanka will benefit in identifying criminals and excluding the innocent efficiently. More importantly, it will support to prevent criminals from having many opportunities to commit mass murders, rapes and robberies and to identify potential victims.

**Keywords** - DNA profiling, DNA database, Electrophoresis gel images, Image processing and Machine learning



## I. INTRODUCTION

DNA typing is an accurate scientific method that uses to identify individuals from the differences in their DNA (Deoxyribose Nucleic Acid) structure. It produces a pattern which is termed as a DNA profile. An individual's DNA profile is a genetic fingerprint which is unique to each person with the exception of identical twins that have the same DNA content. But the probability of having the same DNA profile is less than one in a billion (Great Britain et al., 2015). Therefore, DNA profiles are used as a powerful evidence to identify individuals in forensic science.

Every cell in a person's body contains the same DNA content. Therefore, DNA profiling can be performed by using a very little amount of biological specimens using blood, sperms, muscle, saliva, bones, teeth or even sweat.

The nucleus is the commanding center of a cell and it houses the DNA that codes genetic information responsible for all cellular functions. Several DNA molecules that comprise genes are called as chromosomes. In a human cell, there are a total of 46 chromosomes; 23 chromosomes are inherited from the mother and the other 23 chromosomes are inherited from the father. There are repeating units of the same type of DNA sequence in some chromosomal regions and the number of those repeating units in individuals can vary. Hence those repeated DNA sequences which are known as Short Tandem Repeat (STR) or STR markers are used in human identification in criminology. Tetra-nucleotide repeats are mostly used in DNA typing. DNA profiling is done by counting the number of times each repeating unit occurs within a specific area on the chromosome.

Electrophoresis gel image analysis is the most widely used technique that is used for DNA fingerprinting. Electrophoresis is an electrochemical separation method that makes DNA molecules to migrate through a specific substrate such as polyacrylamide gel under the influence of an electrical current. The output of this electrophoresis process is called as an electrophoresis gel image and that scanned image is analysed by the expert scientists for DNA profiling.

In forensic science, DNA typing is used for two main purposes; to identify individuals from biological samples and to determine familial relationships. Since a DNA profile has recognized as a powerful evidence in forensic casework, the concept of national forensic DNA database was introduced to the field of criminology. Hence national

DNA databases have been established in several countries such as United Kingdom, Netherlands, Australia, Germany, Finland, Norway, etc. and many other countries are developing DNA database systems. Researches highlight that DNA databanks of criminal offenders benefit in quick identification of criminals and help to reduce the crime rates of a country.

Although the existing legal framework in Sri Lanka provides the legal acceptance for DNA evidence in court cases, still a national DNA database is not available. In Sri Lanka DNA profiling was used for the first time in a criminal case when six family members were murdered in Hokandara. Aftermath over 1400 criminal cases and over 3000 cases of disputed parentage have had the advantage of DNA evidence ("Genetech," n.d.). Some significant incidents such as Sarath Ambepitiya murder case, Royal Park murder case and Seya Sadewmi's murder case can be defined as landmark cases in terms of using DNA typing as expert evidence.

The current process of using DNA profiles as an evidence in court cases in Sri Lanka is more time consuming and not cost effective. It requires expert scientists to match profiles. Sometimes DNA samples that are taken from crime scenes are full of dust, salt, etc. The electrophoresis gel images of those samples contain anomalies, hence it is very difficult to analyse those faint images. Security issues also have arisen regarding the current process. Nowadays, most countries are adopted to a novel DNA analysing technique which is called as capillary electrophoresis. The huge cost for purchasing, implementing, maintaining and annual licensing of the equipment based on capillary electrophoresis method is unaffordable to third world developing countries like Sri Lanka.

Therefore, this research paper suggests to deploy recent advancements in computer science field to re-engineer the existing electrophoresis gel image analysing process. Image processing techniques can be used to eliminate the anomalies that can occur in electrophoresis gel images. All the DNA profiles of individuals and crime scenes are stored as a number pattern along with the personal information in the database for further manipulation. Thereby, it will save the time taken for investigations. Machine learning techniques will be integrated to the system to enhance the efficiency of the family relationship matching process. Web technology is combined with the proposed solution to speed up the existing process. It will gain the advantage of using biometric authentication technique to ensure the security of the sensitive data that handles in the system.

The aim of this research is to enhance the efficiency, accuracy and security of the current DNA analysing procedure in forensic casework in Sri Lanka by re-engineering it through integrating appropriate newest technologies introduced in the computer science field.

## II. LITERATURE REVIEW

The literature review emphasizes an appraisal of the similar existing systems. The objective of the literature review is to analyse the focused problems, adopted technologies, proposed solutions and research gaps in previous similar researches. Furthermore, it focuses on evaluating the applicability of previous studies into the problem domain of this research.

A research highlights a four steps algorithm that addresses the bottleneck for further development and reproducibility issues of manual or semiautomatic DNA profiling processes. The four steps include in this algorithm are automatic thresholding, shifting and filtering, detecting and annotating gel bands and data processing. Automatic thresholding is engaged to equalize the grayscale levels of electrophoresis gel image background without affecting the size of DNA bands. The purpose of the second step is to shift the minimum level of the gel image to zero and to remove as much noise as possible using top hat filter. An indirect method consists of top-hat filtering and bottom-hat filtering has been used in the third step to improve the quality of gel images. In the data processing step object detection technique has been used to detect all the DNA bands and to compute quantitative information (Kaabouch et al., 2007).

A method of detection of DNA fingerprint to identify family relationship through the use of image processing based on medical knowledge is presented in literature. In this method, when a DNA testing performer inputs a DNA fingerprint to a commercial program, the DNA gel image is improved by image enhancement as the first step. For the next step the software converts the DNA image to a binary code, reduces small noisy spots and increases the quantity and the size of noisy spots of the size of the binary image to be 45\*26 pixels. In the third step it is correlated by template matching to identify the same DNA positions in terms of mother, father and child. As the final step a complete relationship or no relationship is verified in terms of 10 positions of similarity (Kiattisin and Leelasantitham, 2008).

Various image processing techniques had been used in a three steps algorithm to analyse DNA gel images. Firstly an enhanced fuzzy c-means algorithm is designed for image segmentation to extract the helpful information from the DNA gel images and exclude the unnecessary background that includes blurred noise. The next step named as lane detection uses Gaussian function to estimate and detect the location of each lane on the gel images. For the final step renewing lost bands and eliminating repetitive bands are applied in order to ascertain each band more accurately (Lee et al., 2011).

Literature emphasises image analysis techniques and pattern recognition techniques can be used to obtain quantitative and qualitative information from gel images. The background of most gel images varies because of the presence of noise and some bands of gel images are not aligned horizontally because of non-uniform migration called as 'smile' on gel. The goal of image enhancement is to obtain accurate quantification from distorted gel images. Top-hat transform technique has been used for background removal. The clustering analysis addresses the issue of measuring similarity and dissimilarity between two samples based on the distance between them. The K-means algorithm, ISODATA algorithm and vector quantization are used as clustering methods based on discriminant analysis (Ye et al., 1999).

The "GELect tool" is an appropriate software for DNA diagnosis from 1D electrophoresis gel images. The workflow of GELect comprises three main procedures; lane segmentation, DNA band extraction and band genotyping. This tool efficiently segments lanes from the gel image by detecting curved lanes automatically and it constructs a band model by performing band registration against a reference band. GELect tool has used the band classification technique to perform genotyping from DNA gel images (Intarapanich et al., 2015).

A research done by Maxwell and William provides an overview of the applicability of machine learning approaches for analysing genome sequencing data sets. It presents challenges and considerations in the application of supervised, unsupervised and semi-supervised machine learning methods as well as generative and discriminative modelling approaches. Although the generative modelling gives more compelling benefits than discriminative modelling, discriminative modelling achieves more performance than generative modelling (Libbrecht and Noble, 2015).

cussed researches emphasise, the image quality of electrophoresis gel images plays a significant role in automatic analysis of DNA signatures. Existing researches highlight the filtering techniques still require considerable human intervention and pre-assumptions to define appropriate values for thresholding due to the diversity and quality of images. Moreover, those researches underline that some techniques are not suitable for DNA electrophoresis gel images because they alter the size of the DNA bands.

Most of the existing algorithms consider the data structure of DNA sequences as tree, string and graph. Some researches highlight that it can limit the efficiency of retrieval and the speed of processing.

Some existing systems have used only the image processing techniques according to the addressed problem domains. Some systems have used signal processing techniques or pattern recognition techniques combine with image processing techniques to achieve better performance in DNA sequence analysis. Some researches emphasise signal processing techniques has received a great attention in analysing numeric sequences compared to other technologies such as pattern recognition. Very few researches have considered of applying supervised machine learning techniques such as Artificial Neural Networks in analysis of DNA sequences.

Even though previously discussed DNA image analysing systems are dealing with sensitive data, those systems did not consider about applying robust security mechanisms to those systems since they are not combining with national DNA databases and crime analysis.

This research focuses on addressing the above identified research gaps to deploy a more accurate, efficient and secured IT solution in forensic science in order to speed up the traditional DNA profiling process in Sri Lanka.

### III. METHODOLOGY AND EXPERIMENTAL DESIGN

#### A. Data Gathering

Qualitative and quantitative data that required for carrying out the research were gathered through interviews and document reviews. An interview was conducted with the Head of Department of the Molecular Medicine Unit of the Faculty of Medicine, University of Kelaniya to acquire

the medical knowledge that needs for the project. Another interview was done with the Technical officer of the DNA laboratory of the Molecular Medicine Unit of University of Kelaniya to gather information of the electrophoresis gel image analysing process. An interview was conducted with the Deputy Government Analyst of the Government Analyst Department to gather data about the existing procedure of analysing DNA sequences for court cases. Some DNA electrophoresis gel images, reports and excel sheets of DNA profiles were reviewed during the data gathering process.

#### B. Data Analysis

The data which was gathered during the data collection process was analysed in this phase to define the problem and to identify the limitations with the existing process. Suggestions of the users to improve the current process could be identified through the collected data. Consuming much time and cost, low security, limited analysing capabilities due to unclear images are some of the drawbacks with the manual procedure which could be identified through data analysis. Moreover, the data analysis phase highlighted that the users are also willing to adopt to an automated system to speed up the DNA analysing process. And also this phase emphasized that re-engineering the existing process for better functionality is more important to enhance the efficiency of crime investigations in Sri Lanka.

#### C. Approach

Users of this system are authorized police officers, jailers and laboratory staff. Inputs for the system are scanned DNA electrophoresis gel images and the personal details of offenders or suspects. Outputs from the system are basically a report that indicates the matching probability of the profiles, an email of the report and a SMS alert. The system receives inputs and executes user requests to generate DNA reports and display the output through an email.

#### D. Technology adopted

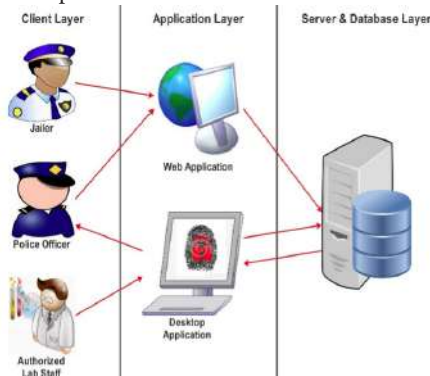
The developed system consists with a web application and a standalone application. The web application has been developed using Bootstrap UI design framework and programming languages such as HTML, CSS, JavaScript and PHP. The standalone application was designed using Swing framework. Java programming language

with object oriented programming concepts was used to programme the functions of the standalone application. Image enhancement process was designed through image processing filters and functions in MatLab. An Artificial Neural Network that is known as a supervised machine learning model which identifies the patterns based on a previously trained dataset, has been integrated in order to develop the family relationship matching process. A MySQL database has designed to store data. Desktops, Scanners and fingerprint scanners are some of the hardware technologies deployed in the developed system.

**E. Design**

The overall architecture of the system can be defined based on three main layers; client layer, application layer and database and server layer. Architectural perspective of the developed system is shown in figure 1.

1) Client Layer: The client layer provides the access to the users of the system. There are two main user levels (authorized police/jail officers and authorized DNA laboratory staff) in this system and access levels are varies from one user level to the other. Therefore the authorized users will be predefined.



**Figure 1. System Architecture**

2) Application Layer: The application layer consists with a web application and a standalone application. The web application is designed for the jailers and police officers. It can be further described through the below discussed modules.

**i. Login module**

This module verifies the username and password that are entered by the users and gives the access to the system for the predefined authorized users. It has given an option

to recover username and password if the username or password is forgotten.

**ii. Insert suspects module**

In this module police officers can enter the personal details of the suspects whose biological samples have been submitted for DNA profiling.

**iii. Insert offenders module**

Jailers can insert the personal details of the offenders whose biological samples have been submitted for DNA profiling.

**iv. Update suspects module**

When the suspects are termed as offenders, relevant details of them such as imprisonment date, number of years of imprisonment, etc. can be inserted to the system through this module.

**v. Update offenders**

This module facilitates jailers to update the information of offenders when necessary.

**vi. Delete offenders**

When the offenders die, the details and DNA profiles of them can be deleted through this module.

The desktop application allows authorized DNA laboratory staff to perform the functions through below described modules.

**i. Login module**

This module allows authorized users to access the system by providing the fingerprint scan.

**ii. One-to-one profile matching module**

In this module user can browse and insert the scanned electrophoresis gel image. The “image enhancement” option has been provided to improve the quality of the image. Then the DNA profile can be generated by clicking the “generate profile” option. After that generated profile will be saved to the database and then it goes for a search against the database to find a full match or a family match. A report will be generated indicating the DNA profile, matching probability and other relevant details. The workflow of this module is shown in figure 2

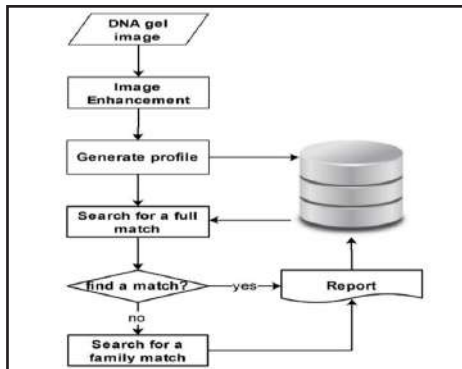


Figure 2. One-to-one matching workflow

iii. Family relationship matching module

Scanned electrophoresis gel image will be browsed and inserted to enhance the quality of the image. Then the DNA profiles of mother, father and child will be generated respectively. Those profiles will be saved to the database and find whether there is a relationship in terms of father, mother and child. After that a report will be generated. Figure 3 shows the workflow of this module.

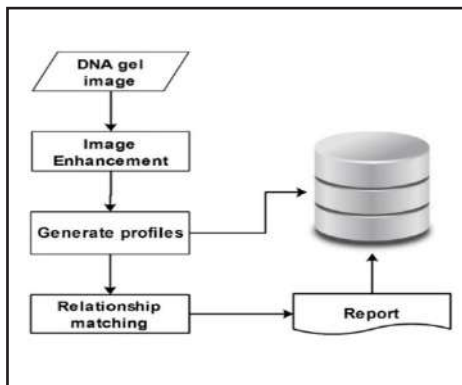


Figure 3. Family relationship matching

iv. Email sending module

The generated reports will be send to the relevant personals through emails in this module.

v. SMS sending module

This module allows to send SMS alerts automatically to inform about the emails.

3) Server and Database Layer: This layer is responsible for managing the server and the database of the system. The server will provide the web connectivity to the web application and the database will store the data that are entered to the system by two applications and the stored data will be provided to the users when necessary.

IV. RESULTS AND DISCUSSION

The above identified filtering techniques such as top-hat filtering, bottom-hat filtering, Fourier transformation, etc. that described in previous researches could not applied directly to the addressed research domain. Therefore, a combination of image processing filters, functions and algorithms were used for the image enhancement process of the system to improve the quality of electrophoresis gel images without altering the size of the DNA bands.

The speed of retrieval and manipulation of data could be upgraded by representing the DNA profiles in number patterns rather than symbolizing them as tree, string or graph.

Moreover, using machine learning techniques along with image processing techniques in DNA profile matching provides a better combination to analyse DNA sequences. It gives more accurate and efficient results than other combinations which are described in the previous studies that discussed in the literature review section.

More importantly, security breaches of standalone application could be eradicated successfully by using fingerprint authentication mechanism rather than using traditional username and password mechanism.

Implementation of the web application that allows police officers and jailers to insert personal details from different places helps to spare laboratory staff from tedious data entering. The distribution of works benefits in enhancing the efficiency of the system. Email sending facility and SMS gateway supports to reduce the paper work.

More efficient and accurate electrophoresis gel image analysing program for DNA profiling and a secured solution for establishing a national forensic DNA database could be provided through this research by addressing the research gaps found in the previously proposed solutions in literature.

## V. CONCLUSION AND FURTHER WORK

In this research work, the author could develop an efficient and secured National Forensic DNA Database Management System by integrating novel advancements in computer science field in order to speed up the traditional electrophoresis gel image analysing process. It will help in quick and accurate identification of criminals that leads to speed up the crime investigation process which plays a major role in an efficient judiciary system of a country. The newest system will support not only to prevent criminals from having many opportunities to commit crimes rapidly, but also to identify potential victims of serial murders, rapes and robberies.

In the near future, the database will populate with DNA profiles day by day. Researches has estimated that the stored DNA profiles of the DNA databases are increased by about 75% in each year (Great Britain et al., 2015). This rapidly increasing data may provide bottlenecks for speedy retrieval and manipulation of data. Therefore, the author infers to integrate Big Data theories and Data Warehousing technologies to handle the large amount of data for further work.

DNA samples that are taken from crime scenes such as gang rapes provides a DNA profile which is called as a mixed DNA profile. There is no proper automatic technique to analyse those mixed DNA profiles. Finding a novel accurate and efficient computerized solution for mixed DNA profile analysing will be an interesting future direction that will help leads to a great upheaval in forensic science and computer science fields.

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# ANALYSIS OF SYSTEMATIC DATA MINING APPROACHES FOR ACHIEVING COMPETITIVE ADVANTAGE BY MONITORING SOCIAL MEDIA

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**Abstract** - This research paper mainly focuses at clarifying how and why social media monitoring is carried out to achieve competitive advantage. A systematic literature review was used to find current insights on the methods used, and so illustrate not only the benefits but also the difficulties that may arise during the monitoring process. Companies use social media to improve their business. More and more companies nowadays use social media tools such as Facebook, Twitter, linked in, you tube, Google+ etc. not only for the purpose of service providing, but also to get in contact with customers.. Resulting this, a large amount of user-generated content is freely available on social media sites which is being utilized by business stakeholders. To increase competitive advantage and critically evaluate the competitive environment of businesses, companies are in need of monitoring and analysing not only the customer-generated content in the company's social media sites, but also the information on their competitors' social media sites as well as the customers. In an effort to aid firms understand how to perform a social media monitoring for achieving competitive advantage and convert data from social media into knowledge that will aid decision making. This review paper also describes an in-detail how text mining provides

a way to analyse unstructured text content on social media sites. The results shows the value of social media and the advantages of text mining as an effective way to gain business value from social media data available in plenty. Moreover over, some recommendations are also given in this paper that aid business firms to develop competitive strategy.

**Keywords** - Sentiment Analysis, Text Mining, Social Network Sites, Opinion Mining, Big Data Analysis

## I. INTRODUCTION

Social media have extremely changed our lives and how we interact with one another and our surrounding world. Recent survey shows that most number of people use social media applications for various types of reasons such as connecting with new friends, contacting old friends, exchanging information, and for making friends. As a result, many business firms are adopting social media to get into this growing trend in order to achieve business values such as marketing management, competitor benchmarking, influencer identification and outreach, market research and reputation management.



Social media monitoring supports typical activities such as customer care, sales, branding (advertising, marketing, and content delivery), and support, product development and innovation. Social media tools that are widely used nowadays have generated a collection of textual data, which contain hidden knowledge about businesses to leverage for attaining a competitive edge. In particular, firms can go deep into the variety of amount of social media data to discover and detect new knowledge (e.g., brand popularity) and interesting patterns, get to know what their competitors are doing and how the industries are changing their trends, and use the findings and improved understanding, to achieve competitive advantage against their competitors (Xing & Zhan, 2015).

## II. CRITICAL EVALUATION OF LITERATURE

### A. What makes social media?

Social media platforms commonly characterized by the profile-based communication and networking of people via the Internet. The focus is addition to disclosing the own personality on a user profile especially the collaborative exchange within a larger community. Under the core aspect of the interest-governed networking People thus find, for example, together in thematically appropriate groups and get the opportunity to talk about specific issues. An important feature of this type of communication within social media networks is the joint design of content through the use of text as well as the aid of image, audio and video content. Moreover, the aspect of networking implies the construction of secondary contacts on primary contacts that would come hardly possible without social media platforms.

### B. Why should business firms care about it?

Within the last one decade, social media has taken the full control of the world. Facebook being the king of social networking sites, it holds more than 750 million active people using it. Even though, the majority of the business firms did not immediately join the social media revolution. Instead, they were focusing on some other modes that aided them in

however, remained shutting, mainly because of a lack of knowledge and an unclear understanding of how social media could be advantageous. They were trying to get to know what social media is and why should the business firms care about it. Unlike traditional media, that provides a one-way experience (in which media broadcast some news about the business for public consumption), social media provides a two-way experience of interaction where consumers can interact with companies. Customers in touch with social media, unlike customers of traditional media, can interact immediately and directly with either the author or the originator of the proffered information. The cross communication and interaction that social media makes possible is the reason what makes social media as a tool for changing the strategies in the business that aids towards achieving business targets.

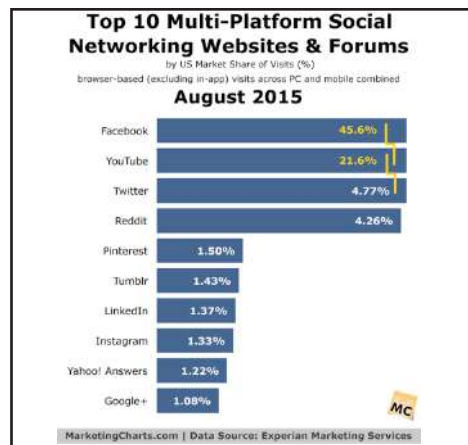


Figure 1 Famous Social Media Sites and Usage of them

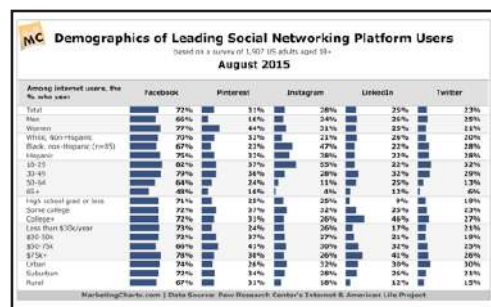


Figure 2 Leading Social Networking Platform Users

developing and improving their businesses. But when the first group of companies joined, some of the rest of the people anticipated the importance of it. Many others,

Figure 1 and 2, elaborates the demand and usage of social media among the people. That would be an ideal example to show the extent to which people could be reached through social media.

**C. How Social Media aids to Competitive Advantage Michael Porter’s Value Chain Analysis**

One way to explore about the impact of social media within a business firm is to know whether the organization will be able to attain competitive advantage with its customers.

In this review article, we will use the concept of competitive advantage as proposed by Porter in his work in 1985. Michael Porter has described how companies can develop sustainable competitive advantage in his publication in 1985. Porter describes three different ways that firms can use for competitive advantage. They are Cost leadership, Differentiation and Focus. Moreover, according to Porter’s model, a firm’s Value Chain composed of all the activities that are required for the production of goods and services. These activities can be major milestone activities that add value directly to the produced goods or services and provide support or secondary activities that add indirect value to end product.

A business firm can find out the ways of gaining competitive advantage by analysing its value chain. This analysis is based on finding the impact of both primary and secondary activities on ay things of Cost Leadership, Differentiation Advantage or Focus. Based on this analysis, the activities identified can be improved so that it leads towards achieving competitive advantage or removing competitive disadvantage.

We use the same logic to social media. In order to utilize social media to gain competitive advantage, organization’s value chain activities that can be impacted by social media are identified (Atzmueller & Martin, 2011). The weight of impact can be measured. This can be analysed for focus, cost, as well as differentiation advantage.

List of social media activities that can be performed in each primary activity can be proposed as follows. Similar activities can also be extended to secondary activities as well.

Firm Infrastructure					Martin
Human Resource Management					
Firm Infrastructure					
Technology Development					
Inbound Logistics	Production and operations	Outbound logistic	Marketing & sales	Service	
Supplier relationship management	Knowledge management for process sharing	Customer feedback	Marketing Campaigns	Pre sales	
		Inventory information	Lead Management	Customer Support and engagement	
Collaboration with suppliers	Intelligence about suppliers	Retailer collaboration	Public Relation	Peer to peer support	
			Advertising	Post sales	
			Reputation management		
			Brand Management		

**Figure 3 Usage of social media in Porter’s generic value chain**

Out of all the generic value chain activities, sales and marketing makes maximum out of social media. Fashion retailers like Myntra.com and food sites like Foodpanda. in regularly use social media channels to run marketing campaigns and offer discounts (Singla, M.L & Durga, A , 2015). In fact marketing campaigns does not only focus on offering discounts. Many organizations segment the users and target them on social media with various offerings as well as to collect feedback. Users who show more interest with these brands their offerings become influencers and customers. From that way, social media acts as an intermediate between consumer and the firm to lead acquisition channel to get more leads that are later managed in a Customer Relationship Management (CRM) system.

Value Chain Activity	Social Media Use Case	Social Media Technologies
Inbound Logistics	Supplier relationship management	Social Networks
	Collaboration with suppliers	Wiki, Blog, KM, YouTube
Operations	Intelligence about suppliers	Social Media Analytics, Twitter, LinkedIn, Blogs
	Knowledge Management for process sharing	Wiki, Ring, Forums, Document Sharing
Outbound Logistics	Customer feedback	Twitter, Facebook, Blogs
	Inventory information	Twitter
Sales and Marketing	Retailer collaboration	Wiki, Blog, KM, YouTube
	Marketing Campaigns	Social Media Marketing
	Lead Management	Twitter, Facebook, Blogs
	Public Relation	Twitter, Facebook, Blogs
	Advertising	Twitter, Facebook, Blogs
Service	Reputation Management	Social Media Analytics, Twitter, LinkedIn, Blogs
	Brand Management	Twitter, Facebook, Blogs
	Pre-sales	Wiki, Document Sharing, KM
	Customer Support and Engagement	Social Media Marketing, Monitoring and Analytics
Procurement	Peer to Peer Support	Wiki, Forums
	Post Sales	Wiki, Forums
Human Resource Management	Hiring (information gathering about potential candidates)	Blog, LinkedIn, Social Media Analytics
	Product comparison including costing	Social Media Analytics, Blogs
Infrastructure	Organization policy sharing	Knowledge and Document Management
	Recruitment	Blogs, Twitter
Technology	Employee recognition	Intranet
	Document Management for contracts and other documents	Social Content Management, Ratings, Feedback
	Innovation Management	Collaboration
	General collaboration	Collaboration

Figure 4 Social Media Usage and its impact on different sources of competitive advantage

Business Goal	Blog	Podcast	Video	Social Networks	Private Community	Recommendation Engine
Build Customer Community	*	*	*	*	*	*
Counter Negative Publicity	*	*	*	*	*	*
Crisis Management	*	*	*	*	*	*
Customer Conversation	*	*	*	*	*	*
Expose Employee Talent	*	*	*	*	*	*
Generate Website Traffic	*	*	*	*	*	*
Humanize The Company	*	*	*	*	*	*

Figure 5 Social Media Tools Used to achieve business goals

D. Key features to be extracted from big data

1) Keyword searching

Organizations can define the topics to be monitored such that it suits their brand images, products and management features. Also keywords targeting the competitive companies also can be defined so that the company achieve competitive strategies over them.

2) Thematic and sentiment analysis

Data available in social media are not organized in a proper way and it's increasingly becoming tedious for businesses to capture, analyse, and make use of it in a timely manner. However, the unstructured data is not useful at all. As a result, there is a need to study how organisations can (a) extract and analyse social media data related to their

business (Sensing), and (b) utilise external intelligence gained from social media monitoring for specific business initiatives (Seizing) (Zhang et al., 2014).

3) Analysis of spread patterns

Monitoring is also used to know of how messages spread in social media. One main approach is to find out causal relations and follow the impact of the interventions of social media. Another one is to follow the spread pattern that makes it able to predict its development. Conversations in social networking sites with the most potential for generating and influencing purchasing decisions were monitored using the analytical tools available on the sites to analyse the spread and impact of social media messages (Kumar & Mirchandani, 2012).

4) Share of Voice

This is referred to as measuring the work that is surrounded by your business firm and your competitors online. By evaluating the presence of other firms within relevant market place, companies can well understand the success of their own business and marketing activities. If the competitor has a greater influence of the voice, it may be time to increase your online presence.

5) Sentiment

By evaluating the sentiments in comments of data available in social media, businesses can understand the negative points consumers have in mind about their product or service. Say if a competition company is not acknowledging for customer complaints, then you can go into that customer and try to introduce our products.

Also by getting to know needs and wishes of a consumer within the industry, a business can try to avoid some mistakes and try to improve them in their own business strategies (Eman & Younis, 2015).

6) Top Sites and Page Types

It is very much important to know where our competitors are active online. Firstly, it may let you know some important sites or forums where a competition brand is dominating its presence, that your firm not aware of. This information will be useful to understand whether you also need to get into that platform to increase your strength or to be a leader in the industry.

Another advantage of finding out that is to get to know where the competitor companies are not actively participating. It would be useful to know if that platform is not at all needed or if that platform is the best place to place your footprint so that without competition you can be a leader there.

### 7) Influencers

By monitoring social media, you will be able to find out influencers, who normally criticize about your product or services or else your competitor's. By identifying that you will be able to correct your weaknesses so that consumers will be satisfied. Or else, by knowing competitor's weakness you will be able to give a better product or service to your customers over the competitor.

### 8) Topics

This is finding out the online conversations about our business or the competitor.

By finding out this you get to know about the emerging trends in the business firms which your competitor is using or you may use that to be the first person to provide services using emerging trends. By finding out the new trends, you can become the market lead.

### 9) Audience Type

By analysing about the people who are discussing about your product, you will get a clear understanding about the interested people and therefore get an idea about audience whom you want to target. Say for an example, you get identify which age group is mostly interested on your products, so that you can develop strategies according to it.

## E. Development methods in social media monitoring

In academia, various methods to navigate, collect, analyse the content, sensing and social media topics have been proposed. Many techniques categorization unstructured data were adapted and implemented in the social media studies and areas of knowledge. These efforts require interdisciplinary research skills, since they involve the treatment of raw data regarding the search for information quality and significance as displayed, most appropriate to the situation. Reweaves points out that due to the volume and complexity of data, simple models are inadequate

and, therefore, the process of data mining of social media requires a comprehensive approach, highlighting the need for a unified approach to explore the data structure for efficient identification, classification and forecasting topics, issues and relevant models. Countless techniques such as extraction, sorting or categorización, feature analysis, linguistic analysis, content analysis, association between texts, grouping and summary can be used to extracted knowledge models or interest sentences and unexpected textual documents. Researchers say the clustering technique offers the advantage of revealing trends, unexpected correlations or patterns in the structure of the data that had not been budgeted. Scholars emphasize that the cluster analysis is a technique well explored in data mining and, according to Abdous, He & Yen (2012) explored technique that allows display models, grouping similar words and terms or values which are also attributed & similarly coded. The same authors say that even a perspective of data mining, clustering also can be used for this. Introduction of Artificial intelligence techniques to monitor social media is also a progress in the development of social media monitoring. Some of those type techniques are:

#### 1) Text Mining

Data mining, text mining activities as a source of data that accepts text work is intended to gather data on other defined structured text. For example, the classification of text, segmentation of, subject extraction from text, production of class particle, emotional analysis, text summarization, and entity relationship modeling aims such studies.

Bringing information within the scope of the text mining efforts in order to achieve the above goals (information retrieval), syllable analysis (lexical analysis), word frequency distribution, pattern recognition, information Extraction, data mining and even visualization (Wei Jin etal).

Text mining studies aim to achieve results through the text more statistically. Often for feature extraction using natural language processing, text mining studies are used. Introduced in 1995 by Ronen Feldman and Ido Dagan as "Knowledge Discovery from Text (KDT)". In the research terminology text mining is not a clearly defined term. In analogy to data mining in the Knowledge Discovery in Databases (KDD) Text Mining is a largely automated process of knowledge discovery in textual data, which is

to enable an effective and efficient use of available text archives. Comprehensively we can say text mining as a process of compilation and organization of the formal structuring and algorithmic analysis of large collections of documents for the appropriate extraction of information and the detection of concealed content relationships between texts and text fragments.

The different views of text mining can be sorted by various typologies. These kinds of information retrieval (IR), the document clustering, the text data mining and KDD are repeatedly referred to as sub-forms of text mining.

Most similar to the text mining, data mining with this, it shares many methods, but not the subject matter: While data mining is usually applied to highly structured data, text deal mining with significantly weaker structured text data. In text mining, the primary data are therefore in a first step, more structured to allow its development with methods of data mining. Unlike most tasks of data mining, multiple classifications are usually welcomed in the text mining (Miloš & Milana, 2008).

## 2) Web Mining

Web mining is a process used for meaningful patterns from Web resources, profiles, physician data mining techniques (to find a useful correlation is hidden among other data, to find such a trend Extract the actionable information for future decisions ) to be applied once. Its application fields include information filtering and monitoring of such competitors as patents and technology development, mining utilization of the web access logs for analysis, browsing (breadcrumb navigation in your web), etc. support.

Web mining is part of the data mining specialist for disclosure of information on the Internet, especially the World Wide Web. Huge databases are rich in data, as well as poor information that is hidden in stored data. Data mining helps to reveal important information and knowledge applied to the data.

Also, greatly contributes to decision-making, business and science. Mining the Web is used by a variety of companies (personalized marketing), as well as governmental organizations (fight against terrorism). Companies can establish better relationships with their customers because they can better meet the needs of consumers, and react more quickly to their queries. There are also problems

in mining web. The technology Web mining does not cause any problems, while the use of these technologies in the personal data can do damage. The largest such issue would be invasion of privacy. Privacy is violated when information about an individual obtained, used and disseminated without his knowledge or permission. Another such problem is that companies that collect data for a specific purpose, such data can be used for something completely different. The truth is that these companies are responsible for the issuance of all of this data, and if you notice some irregularities followed by a lawsuit, but there is no law that prevents them from trading in such data (Sheibani & Amir). As the popularity of the World Wide Web continues to grow, there is a growing need to develop new tools and techniques that will improve the overall usefulness.

## 3) Named Entity Recognition

The named entity recognition is a subtask of information extraction activity in the documentary corpus. It is to look for text objects (that is to say a word or group of words) be categorized into classes such as personal names, names of organizations or businesses, place names, quantities, distances , values, dates, etc.

For example, you could give the following text, labeled by an entity named recognition system used in a survey.  
Jim went to see Kim at 9:00 of May 18.

This text can be recognized as <PERSON>Jim</PERSON> went to see <PERSON>Kim</PERSON> at <TIME>9:00</TIME> of <DATE>May 18</DATE>.

The text of this example is tagged with XML tags. Most labeling systems use formal grammars associated with statistical models, possibly supplemented by databases (lists names, names of cities or countries, for example). In large surveys, manually written grammars database systems perform best. The downside is that such systems sometimes require months of drafting work.

Current statistical systems use to share a large amount of pre-annotated data to learn the possible forms named entities. There is no need here to write many rules in hand, but to label a corpus that will serve as a learning tool. These systems are also very costly in human time. To solve this problem, recently, initiatives such as DBpedia Yago or seek to provide semantic corpus that could help design labeling tools. In the same spirit, some semantic

ontology such as NLGbase is largely oriented labeling. Since 1998, the annotation of named entities in texts met with increasing interest. There are many applications call for finding information or, more generally understanding of textual records.

There is not strictly speaking labeling standards. Labels are heavily skewed depending on the application needs: we usually find the label type classes roots Person, Organization, Product, Place, plus the label length and quantity (time and amount).

**F. How these techniques are implemented in social media monitoring**

Social Media monitoring can be broadly defined as using Social Media data sources, many of which can be taken automatically using some extracting tools, and choosing and aiming concepts and word types to analyse market behaviour and interaction(Sponder & Marshall, 2012). Thus, data collected from this sort can be summarized, analysed and classified and passed through various types of algorithms to get patterns and trends that are useful to achieve business goals. In order to do this, the social media need to be monitored on a specific time basis and filter the useful things and wan to decide which is worth to consider upon. This is known as social media monitoring.

Monitoring social media using text mining has been proposed by various researchers as depicted in following pictures.

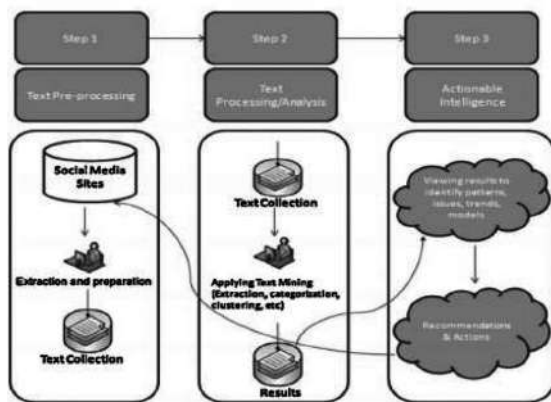


Figure 6 Implementing text mining

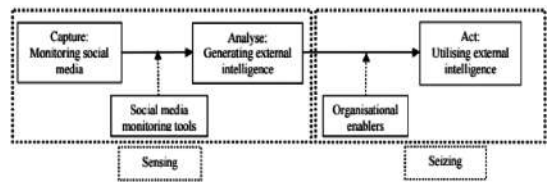


Figure 7 Big data analysis of Social Media

**III. CONCLUSION AND RECOMMENDATIONS**

Most business firms, government agencies, non-profit organizations (e.g.: Hospitals, universities, associations, etc.) and individuals, such as writers and celebrities use media monitoring as a tool for identifying mentions of their organization, their brands and leaders in news media. some organizations also provide media monitoring tools to track the success of their messages to find information about competitors and relevant specific issues on the organization to manage the benchmark performance against competitors, corporate or brand image, to gather the information industry to create a better to understand the strengths and weaknesses of corporate communications, to identifying new business opportunities, and for other purposes.

Despite the initially purely private use of social networks were in the past few years an increasing number of private companies about to adapt their presence on the Internet to Web 2.0 developments to benefit from the advantages. Primarily social media provide platforms for companies, a relatively inexpensive but accurate marketing tool because of the wastage of classical forms of marketing can be significantly reduced by targeting of customers and potential customers. Furthermore, the operation of a social media concept supports the development of new target groups, mainly the move on the internet and can hardly be achieved through traditional channels. In this context, especially the resulting economic potential of viral marketing is to be mentioned the results from the typical social media concept of networking between users.

Rather than only monitoring social network sites, I recommend that the use of internal networks can also be good for performance improvement of a company which leads to gaining competitive advantage. Such a system is not only used to improve the working climate by facilitating and more informal communication among the employees, but also helps to uncover organizational weaknesses and eliminate them.

## ACKNOWLEDGMENT

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# DOMESTIC SERVICES MANAGEMENT SYSTEM: A SRI LANKAN PERSPECTIVE

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**Abstract** – Technology has granted many opportunities for the people in need of employment around the world. It has created marketplaces as well as marketspaces providing a stable economic benefit. However, in this modern society which have plethora types of media & mass communication approaches, so far it still failed to deliver swift and convenient methods to request domestic services. Home repairing services, beauty, and health-related services, events organizing related services and business services are few services still discoverable through newspapers and yellow pages in Sri Lanka. This leaves a necessity to create a solid platform for the skilled micro employees to provide their services continually as per the customers' services requests. A mobile App-based service marketplace will be a good enhancement for the current context to locate, categorize, and provide rates and feedback about nearby micro employees who are willing to provide their services for the domestic customer's request. This system will categorize their jobs and its work providing more niches to the customer's request. The main objective of this paper is to emphasize that mobile technologies can be used to enhance the human life by helping them to hire services using a convenient platform. As for the results, this system can influence the 4.7 of an unemployment rate of Sri Lanka (Labour Force Survey, 2015) by creating a separate easily accessible marketplace without any entry barriers for the micro employees who are willing to start their own businesses.

**Key Words** - Smartphone, Services, Domestic, Micro-Employees, Android, Unemployment, Cloud-Platform

## I. INTRODUCTION

The growing capacity of smartphones and in related technologies have opened up a vast new avenue for the communication and e-commerce sectors, prompting many to evolve from using desktop or laptop computers to handheld mobile devices. 2015 Central Bank reports show that every 100 people in Sri Lanka own 113 mobile phones and 13 fixed lines by the end of the year 2015 (Annual Report Central Bank, 2015). And latest statistics issued by the Internet World Stats emphasize 27.4% of the Sri Lankan population has access to the internet (IWS, 2016). And this statistics correlates that people are using mobile devices as a simplicity to achieve their daily tasks more and more. The application of mobile apps to daily activities are not entirely new to this generation. People tend to buy goods more through mobile apps compared to past decade. But unfortunately in Sri Lanka for the service sector, there are limited ways to request services for any domestic needs. This Domestic Services Support System – Android App will be a good addition for the people to interact and find about more and more about what kinds of services are available out there or nearby. These applications will be a native Android app which will run on any smartphone running on Android OS without a hassle to use a web application separately. The back end of this application will be controlled by the Google firebase cloud server which gives more control over the application which performs following tasks. And there will be two separate apps for customers and service providers to make it more comfortable and convenient to operate their tasks.



Domestic Support System includes following features:

- Friendly in UI and UX sections

Attractive and user-friendly interfaces will guide the users and service providers to use the application more often. Both the apps will start with introductory slides to educate the parties on apps features.

- User Base Authentication

The service provider identification will be thoroughly checked according to their information provided as for the security measures.

- Categorized job market

In the current service sector of Sri Lanka propose the wide variety of services to the market such as health care, cleaning, tradesman ships, consultancy, builders etc. By using this application the customers can access and choose the exact service for their needs.

- Connects parties more efficiently

The customer app will provide the nearest service provider according to their service request, making more time efficient and less stressful for the customer. The customer location will be taken to determine the service provider location around him.

- Rate service providers

After the service or services are provided the customer can give rates for a service provider according to his or her performance. This option will be more helpful for the other customers to decide whether they need the service from that particular service provider.

- Real-time service provider tracking

This application will provide real-time tracking option for the customer to keep track of the service provider until he or she arrives at their premises.

- Feedback Monitoring

The customers can also add feedbacks about the service providers' performance along with the rating. This open opinions will help other customers to decide their options available more straightforwardly. The feedback will also be useful for the customer to make quick accurate decisions.

- Creates professional labor pool

In the long run of this application can actually help the micro employees to become more work efficient at their work and be professionals.

## II. RELATED WORKS

### A. Services Vs Goods

Goods and services are the main things people request in their daily economic life. Sri Lanka shows a very high growth rate in the service sector and its holds 62.5% out from other main economic activities. (Annual Report, 2015) IT knowledge advancements and computer literacy increment have been a direct influence on its growth. Goods are sold around the country vastly using many media (Internet, TV, Internet, Mobile apps). We could find many mobile apps for websites such as eBay, AliExpress, Amazon etc. (Ebayinc.com, 2017). But unfortunately, there is no single mobile application in Sri Lanka to provide categorization for Micro employees. However, this system fills out the void that created it. Providing a better marketplace and a marketplace to both of the parties.

### B. Server selection

Most of the mobile app developers are tended to use Amazon Web Services (AWS) as the backbone to their mobile app nowadays. It provides quite a number of options for the developers serving as a cloud computing structure. And this is the backbone of Urbanclap (similar services providing app). Even though this has so many features it lacks library updates and deprecated functions. Here in this Domestic Services Support System as the backbone it will run along with Google Firebase. The Firebase was recently acquired by the Google and it provides seamless support for the app development in many platforms (Android, iOS, C++, Unity).

### C. Database

A Database is an organized collection of data. Databases can be stored locally on your computer or can be stored in cloud storages. Every application whether Android, iOS or web application, it has its own database (W. Cao, 2014). In the Android app, we can create databases using SQLite, shared preferences, websites or some cloud-based storage sites. Firebase is also providing database structure

backend for Android, iOS and web applications (Firebase, Online). Using only the inbuilt SQLite functions of Android apps is not enough for an app. It is because in the long run the stability of the app gets affected by the data accumulated on a daily basis. As for the solution, Google Firebase database will be used which is NoSQL and scalable database (C. WODEHOUSE, 2017). And it will not use any query based SQL languages instead it will use JSON nodes for index information (Json.org, 2017). This real-time database will use cloud technologies to share information across the applications. The moment the data being updated the app in that instance will be updated according to the data entered.

#### D. Convenience

A limited number of websites are available for micro employees in Sri Lanka such as hodabaas, Mason, Salondhammi and findbas. But unfortunately, all of these sites are restricted to their own categories and the categories are also limited (e.g.: Beauty and Construction) But Domestic Support System will combine all the available services together to one place and improve the convenience to the customers to access them by using a single mobile app. This system will look into more market niches. This includes Entertainment services, Event services, Health related services, Education related services (Piano lessons, Guitar lessons and etc.) And much more other services out there in Sri Lanka. (Hodabass.lk, 2017) (findabaas.lk, 2017) (findbass.lk) (Salondhammi.com, 2017) (masons.lk, 2017)

#### E. Authenticity

As we search through the web we can find many people who are willing to provide their services. But when it comes to services sector security of the people is a major concern for the developers if they are going to add service provider information's to the system. That is why this system has introduced two separate mobile applications. One for the consumer and another app for the service provider. By using the service provider app, the service providers can list their service to the customer. The mentioned process will undergo go many authentication steps. Unlike above websites, this system will use OAuth 2.0 (OAuth.net, 2017) and OpenID (Openid.net, 2017) which will improve the security along with this process time. Most of the service providing websites only request National Identity card information. This will create questions at the service providers' knowledge on their field of work. This can be

overcome in this system due to its thorough processes. Unlike in customer's app, the service provider app will include security checks and information validations.

#### F. Real-time Tracking

After ordering a good/thing it is a normal to wait till it arrives. Likewise, customers will observe the arrival of the service provider. In Urbanclap app (Urbanclap.com, 2017) after the customer request a service they wouldn't able to find out whether the service provider is going to provide their service certainly. But in this Domestic Services Support System, it will be integrated with features to track the real-time location of the service provider. This will help customers to proceed to their other duties until the service provider arrives (M Singhal, 2012). By using Google Maps API and new Google Maps location share functions the whereabouts of the service provider can be easily tracked. Unlike those websites, this app will search the surrounding area by Google location services not showing entire labor workforce to that area.

#### G. Rating

Rating, voting and other feedback mechanisms are heavily used in today's mobile apps, app markets (Google Play) and in social media systems, allowing users to express opinions about the content they used and still using. Web sites providing odd jobs and other services do not provide workers past worked history information or customer experience by any sort of ratings and feedbacks. These problems can be neutralized by Android native rating libraries and integrating feedback features.

### III. ANALYSIS & FINDINGS

To examine the demand for the services a face-to-face interview was conducted around the Galabaddha Waththa, Malapall, and Kottawa area. In this interview, most of the people have mentioned the difficulty in finding a skilled worker for their needs. The majority of them rely on newspaper and neighborhood community to find a worker (J. Cheng, 2014). This current process consumes time for the customer. And because of this service providers scarcity, the customer may have to pay a higher price for their work they trying to fulfill.

This proves that people who are willing to request services are going for this sort of extent to find their suitable worker. Similarly, there is also service bill for guitar lessons, individual tuition classes, piano lessons, event planning consultancies.

## IV. METHODOLOGY

### A. Logical architecture

The user-friendly user interface will be the main concern of this application because by making a good impression on the people at the first glance, can improve the usage of this mobile application. And Hassle-free registration process along with service requesting process is the second highest prioritized function will be running inside this application. The following three-tier architecture diagram summarizes the system's basic processes (Fig 1).

As mentioned two separate mobile apps coordinate the two parties. As shown in above architecture. At the beginning, the customer requests the services through a mobile application and from application layer it will redirect into services and database layer. In this layer, all the JSON nodes requested through application layer will be submitted and requested output will be generated. Google Firebase will then redirect this request to the service provider through service provider application. In the end, the service provider read the request and confirm the request to provide services. The admin monitoring presence or the Google firebase dashboard will help the developers to monitor and analyse service providers and customers' application usage history. And admin will be in charge of removing any suspicious or unskilled workers if any customer complains him or her through the rating system or from feedbacks.

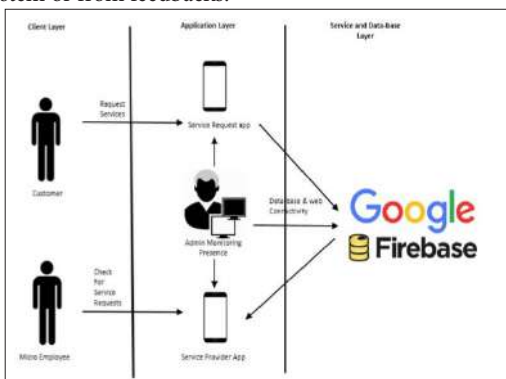


Figure 1 Basic System Architecture

These two mobile apps are developed using Android Studio. Which is an integrated development environment (IDE) created by Google Inc. (Developer.android.com, 2017) Java, XML and SQL languages will run in these apps core. Most of this application's core functions will

be written using Java language (Docs.oracle.com, 2017). Extensible mark-up language (XML) will be used to design the overall user interface of both of the Android apps. Google firebase will hold its own real-time database procedures to update the customer requests and service provider.

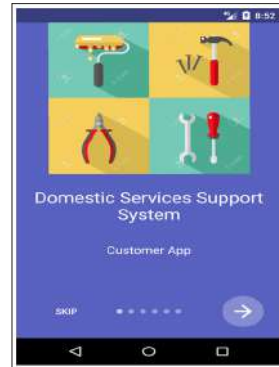


Figure 2. Interface of the Android app

### C. Database Tier

The structure of this applications' database will be different from traditional databases. Because the structure of this database will not use traditional relational database schema. Instead, the structure of this database will be built using document-oriented database architecture. The following (Fig 3) brief about how data stored in the relational database and non-relational database differ from each other. (C. WODEHOUSE, 2017)

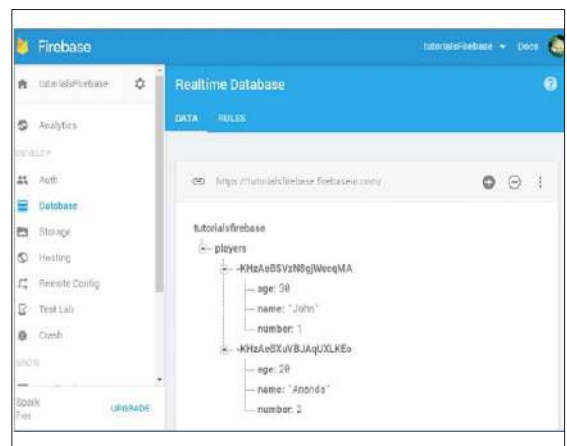


Figure 3. Firebase

The following reasons have influenced over the selection of NoSQL database. (S. Chickerur, 2015)

- Data Structure Issues

Having many different types of data can be influence the overall structure of the database. In NoSQL database this issues may occur but with document oriented databases this issue can be overcome by storing data in one place without the need of defining the type of data it has to store in.

- Cloud computing benefits

Google firebase supports development of the mobile app with many good features. It provides real-time database, file storage and hosting services in one single place. With this scaling up the database will not be an issue. Mostly the cost will be effectively affected, this would help to save considerable cost.

- Rapid development.

If the development of the app within a limited time frame, turning out quick iterations or requiring to make regular updates to the data structure without a lot of interruption between versions, a relational database will slow you down. Document-oriented database does not need to be prepared ahead of time.

## V. DISCUSSION

The idea for this application was first laid out by the world's corporate giants like eBay, Amazon, etc. They successfully provided a solid base for the sellers and consumers to come out and sell their products more freely. But they also trying to fills the gap between the needs of services to the customer. In Sri Lankan context also we can see this void located in heavily E-commerce sector. In order to set itself apart from traditional classified sites and other directories, this application will provide matchmaking results for the JSON nodes requested that guides and help users to sort through a large array of services in their city, but also make sure providers get good leads that result in good business connections. This will make very simple and convenient to the user to hire a trusted service professional. Thus it is essential to develop a solid index to match corresponding service provider to the needs of the requesting customer. The mentioned technologies and mentioned application

of android technology and its combined technologies have proven to be very resourceful in real life. Many positive outcomes were achieved by this application of android technology.

## V. CONCLUSION

The demand for the customers' service request will continually grow along with the development of the country. By using Domestic Services Support System, customers will be able to find individuals with the experience and knowledge (Professionals) regarding the service they require more conveniently in a shorter period of time. And furthermore, it brings the portability to the users saving their time and money. The unemployment issues also will be addressed through this system and problems of micro employees will be considerably reduced. For the upcoming technologies, these Android-based apps can be implemented and upgraded as it grows.

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# AN ONLINE HELP DESK SYSTEM TO HELP STUDENTS IN LEARNING

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**Abstract** -This paper reports about a field study done on online helpdesk system for General Sir John Kotelawala Defence University (KDU) and about the system prototype which was built according to the analysis of gathered data. When considering the current learning process prevailing at KDU, when participating in lectures, students do not get a chance to present their problems to the lecturers very often. Therefore, we address the problem of not having an opportunity for the students, to solve their problems that arise during the lectures. To overcome this problem, a Web Based Help Desk System was introduced for KDU. Through this Online Help Desk System, students will get the opportunity to present their problems to the relevant lecturers, whenever they need a further clarification on any subject material. Students are facilitated by the option to choose the priority level of a question. So, unlike other help desk systems, this system will ensure that each question posted on the system will be answered as soon as possible according to the priority level preferred by the student, by notifying the lecturers by an email. The accuracy of the provided answers will be assured since, only the authorized lecturers of KDU have the eligibility to get registered to the system as an answer provider. When developing this Online Help Desk System, the focus was given to build a system, which will give more time critical and task sensitive online help.

**Keywords** - Online Help Desk System, Question and Answer System, Web Based Application

## I. INTRODUCTION

### A. Prolegomena

In the modern world with the development of technology in the area of learning, e – learning has gain a prominent place. Among them, more attraction has been drawn towards Online Help Desk Systems. This can also be known as Online Question and Answer Systems. Online help desk systems can bridge the gap between the user's need for simplicity and the software's complexity, by providing relevant information within the very specific context of a user's lack of familiarity with a particular concept. This is a common definition about the online help desk systems.

When talking about help desk systems, at once the idea that comes up to our mind is the help desk system that is available in every software and systems. Those help desk systems will provide solutions for the problems regarding the usage of system and services rendered by the systems. However, in this research, the main concern was drawn towards the implementation of an online help desk system in an educational context. That means this system will help the students to solve their problems that arise during their lectures regarding subject matters. Therefore, with the help of this system, students will get the opportunity to clarify their doubts regarding the subject matters whenever they need.

## B. Background and Motivation

Online Help Desk System is a research area that has recently gained a lot of interest. A large number of universities and researchers have done research on this topic. At the early stages of this research area, more attention has been given to develop this system only concerning the system point of view. But Ye Chen, a PhD student in the Department of Information Systems at University of Maryland has done a research on developing a Help Desk System concerning also the organizational factors and human behavioural factors and not only the designing perspective. In his research he argues that organizational and human behavioural factors are also important and should take into consideration to provide the most appropriate service according to what actually the users expect from online help desk system. Also he has done this research on a context of an educational institute. (Chen, 2004a) This was the main motivation factor which lead to do this research.

## C. Problem in Brief

The Department of IT in KDU Rathmalana offers two degrees. They are the BSc in Information Systems and BSc in Information Technology. Currently the Department of IT has three intakes with more than 100 students. Initially the team has built this system for the students of all three intakes who are reading for the BSc in Information Technology Degree.

In each intake, there are a considerable number of students. Each day the students will have two lecture sessions, from 8.00 am to 2.15 pm. One lecture session will be three hours long. When the lecturers are conducting the lectures, the students will get many problems regarding the particular subject. Due to the lack of time and since there is a substantial number of students for a single lecture session, all the students might not get a chance to present their problems to the lecturer. Sometimes some students hesitate to present their problems to the lecturers in person because they are shy or less confident. Moreover, because of the busy schedules of the lecturers, the students will not be able to meet the lecturers even after the lecture hours to get solutions for their questions. Also, while the students engage in their further studying at home they might get doubts. But they will not have an opportunity to solve those doubts even by surfing the internet, since the accuracy of the answers that can be gained by various other websites cannot be assured. These are the main problems that the students face when they engage in their studies.

To address the above mentioned problems the team built a Help Desk System which will be fully web based and automated. Therefore, the students will be able to present their problems to the lecturers from anywhere anytime and also the lecturers will be able to provide answers for those questions from anywhere, anytime. Simply, this system is a platform which connects the students and the lecturers, for the benefit of the students.

The objectives that were expected to achieve by doing this research were, to conduct a critical review on technologies used in currently available Online Helpdesk Systems and to design and develop an Online Helpdesk System for the students of the IT Department of KDU, which will be beneficial to encourage the students to engage in their studies without doubts and with more clarifications and understanding, as well as to increase the interest in learning.

## II. LITERATURE REVIEW

### A. Introduction

In this section, we critically review the research conducted in web based helpdesk systems. This review has organized in three sections namely early developments, recent advancements and future direction. Finally, this section presents the research problem and the technology that need to be adopt to solve the problem.

### B. Early Developments

A help desk system can be described as “The process of handling unstructured data in a structured manner”. As stated by Gyll and Gyll (Gyll and Gyll, 2003) a general definition of a help desk system is, to be able to create a stable environment where it is easy to make decisions and find solutions to problems. Help Desk Systems has developed in order to help the organizations to effectively communicate, organize, track and report issues. The importance of web based help desk systems is that the organizations can access information at anytime and anywhere(Hafifi and Ariza, 2012).

A technical definition of a help desk system is, it is a collection of one or more programs designed to provide user assistance embedded in a larger program or computer system. Although designers frequently integrated help programs with the application, help systems might also be separate and run concurrently with the system (Chen, 2004b). The issue in this definition is its narrow scope due to its application-oriented nature.

Along with the prevalence of a diverse and heterogeneous range of software and hardware systems, an online help system serves as a gateway to all kinds of computing resources. With the massive development of technology, online help systems are also developed largely. The evolution of help systems has come from book oriented to constructive through exploratory. Book oriented online help represented paper-based documentation, which highlighted static and linear structure. Although this traditional organization of contents was familiar to users, the limitation of this approach was, not quite capable for satisfying the complicated information needs of particular users in specific contexts for distinctive tasks. Due to this it paved the way for hypertext-based online help, either exploratory or constructive. The significance of exploratory online help was that it provided multiple paths to navigate a document thus increasing the interactivity. Its flaws were unfamiliarity to users and difficulty to read through. Constructive online help allowed customization by users, feedback to developers, and capability to re-conceptualize tasks. This online help conception evolved along the dimension of user-document interactivity(Chen, 2004c).

Due to these reasons, it is clear that online help systems should be considered in an organizational context rather than from an application-oriented context.

According to Sondheimer and Relles (1982) online help systems are categorized into four dimensions,

- (1) Access method - How users input help requests.
- (2) Data structure - How the help information is organized.
- (3) Software architecture - How users and the help systems interact.
- (4) Contextual knowledge - To which extent the help information is relevant to the environment and the tasks of a specific user.

But this categorization had some drawbacks. Bergman and Keene-Moore (1985) argued that one shortcoming of this categorization was that these dimensions only took into consideration software related aspects, omitting user interface related factors.(Moré et al., 2012)

### C. Recent Advancements

In the recent advancements of online help systems educational institutions has started to incorporate this help system with e learning by integrating them as question and answering systems.

Universities or higher education institutions have started introducing the open source software and practical experiences have been reported by them in various scientific journals. Introductory examples of e-Learning and their effectiveness have been reported. Construction and application of an e-Learning environment are often based on open source packages, such as Moodle, Stack Overflow, Yahoo!Answers, wikiAnswers etc... (Brill et al., 2002)

Since e-Learning offers a learning environment which exceeds spatial and time-based restrictions due to the use of web technologies, its usage has been continuously increasing every year(Lebedeva and Zaitseva, 2014). All information systems built for the purpose of educational support are summarized under the term “e-Learning”. Installation and operation of an e-Learning environment are already playing an important role in educational facilities, such as universities and anyone can install an e-Learning system without much effort. (Moré et al., 2012)

Although many e-Learning/question and answer systems have been implemented by Universities around the world, these types of systems are not being implemented in Sri Lankan Universities. This helpdesk system which is to be implemented have new options such as, notifying the relevant lecturers according to the relevant categories and also an option where an e-mail is to be sent to the lecturer if a student submits an urgent question which we do not frequently come up with other e-Learning systems. This is the novelty of this system.

### D. Future Trends

The future trends of e – learning systems include intelligent question answering systems. QA systems have developed over the past few decades until they reached the structure that we have nowadays. QA systems, have a backbone composed of three main parts namely question classification, information retrieval, and answer extraction. Therefore, each of these three components attracted the attention of QA researchers(Allam and Haggag, 2012).

The main challenge that is faced by the future help desk systems is that how to make it flexible with the changing technology and thereby provide customers with a comfortable and reliable customer support which is based on customer centric approach. The solution for this challenge is implementing them in a way such that they will accompany the changes as well as the growth of



technology (Barskar et al., 2012) (Fukumoto et al., 2013). The fast rise of information technology, mobility of users, and security as well as compliance regulations are affecting the future of help desk more than ever. In this regard, help desk software programs are viewed to progress towards an operationally focused management that gives primary importance on the main competencies of customer care. With customers getting bolder and technology-savvier, improving in this regard is seen as necessary. (Ómarsson, 2010)

Changes in technologies are driving many changes in the help desk. Better help desk software functionalities are viewed to possibly modify, if not entirely revolutionize, the future of customer support by focusing more on strategic solutions and higher-level problems.

When creating the correct help desk solution, it is important to pay attention to the communication flow between a business and IT.

Therefore, the IT help desk shifts from being a preemptive strategy to an important strategic function of a business that provides essential business value and have a dynamic part in assuring a company's success not only at present but also beyond.(Mishra and Jain, 2016)

Therefore, the identified problem from the literature review is that developing a helpdesk system, which is organization oriented and which is cable of coping with the changing and growing technological advancements.

### III. METHODOLOGY AND EXPERIMENTAL DESIGN

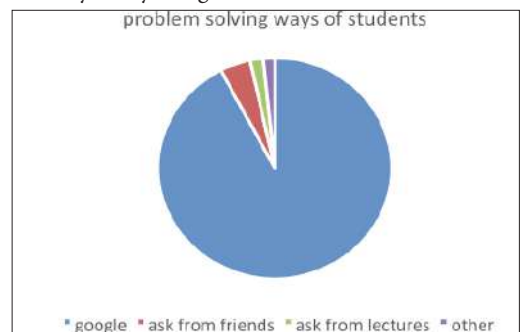
#### A. Data Gathering

Combination of qualitative and quantitative methodologies were used as data gathering techniques when designing the requirement specification. Questionnaires and interviews were the main data gathering methods that were used to gather the requirements and the information. Apart from that, observations were also used. All the required data were collected by using a selected group of personnel within an exact period of time. Interviews were conducted with both the lecturers and the students. And the questionnaires were used to gather the data from the students because, it is an efficient technique to gather data from a large audience. Face-to-face interviews were conducted with a selected group of lecturers who conduct

lectures for all the three intakes, 5-10 students from each intake and with the Head of the Department. When conducting the observations, the team participated in a lecture and observed what really happen in a lecture and what the problems that the both parties face are. Although this method was a bit time consuming this was the most accurate method for data gathering because it helped to get the experience of the real situation.

#### B. Data Representation and Analysis

According to collected data, the team identified that most of the students were used to search their problems in Google and also they have stated that, since the answers available in various websites are different from each other, students find it difficult to get correct answers on the internet and it was time consuming. Some students were used to call lecturers or meet them in person to ask questions. But, they also stated that, most of the time lectures were not available to answer the calls or meet students due to their busy schedules. Some students were used to ask from friends but there were problems in the accuracy of the answers which provided by friends. So the current process was time consuming and less efficient. The data gathered by using the above mentioned techniques were analyzed by using tables and charts.



**Figure 1. Data Representation**

Through examining the data, the team were able to clearly identify the existing process, problems and limitations prevailing in the current process and the suggestions of lecturers and students regarding the existing process. Some of the identified limitations of the current process were due to various reasons such as, all the students don't get the opportunity to present their problems to the lecturers, inefficiency and time consumption. And through this analysis it was proven that the students and the lecturers were highly satisfied with the proposed system. Finally, after this analysis the team came to the conclusion, that

a fully automated system should be developed to re-engineer the existing process to make it function better.

**C. Approach**

The main users of this system are the students and the lecturers. In addition, a system administrator can also access the system for registering users, maintenance, troubleshooting and upgrading. There are five major different types of inputs concerning students and lecturers. Students can logon to the system by entering username and password. Then they can post the question, the subject area which the question belongs and the priority of the question. Lecturers can also logon to the system by entering username and password. The outputs of the system are solutions for the problems submitted by the students, ratings of the provided answers, feedbacks and e-mail notifications.

**D. Technology adopted**

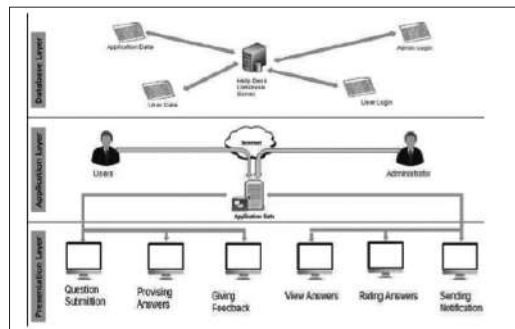
The most appropriate technology for developing the system should be decided by considering the system domain and the requirements. It is much significant to select the technological methodologies which will be capable to satisfy both the functional and non-functional requirements of the system. Since the proposed Online IT Helpdesk system is a web based system the team had to pay more consideration when opting the technological facet. The technological methodologies had to be selected in such a manner that it will help the system to be available at anytime, anywhere and also to make it efficient and effective. With an in-depth analysis of the system requirements, PHP has been used as the main programming language to develop the backend of the system. The database of the system has been implemented using MySQL. The front end of the system has been developed using the programming languages HTML and CSS and also the bootstrap framework was used to make flexible and user friendly interfaces. Finally, the validations of the forms have been done using JavaScript.

**E. Design**

Design of the system is described under two topics as overall system architecture and modular architecture.

1)Overall System Architecture

This section will describe the three tier architecture of the system. The system as a whole is mainly divided into three layers as Client Layer, Application Layer and the Database



**Figure 2. System Architecture**

2)Client layer

This layer builds the interaction between the users and the system. Mainly in a system the human computer interaction is achieved through interfaces. Therefore, this is the layer which holds the interfaces created according to the user requirements. There is a variation of the visibility of interfaces to the users. At the beginning all the users get the access to the same login interface. But after the user authentication the interfaces accessible for the users are different. This has been done according to the role which the users play in the system. The main function of this system is question submission and providing solutions. Therefore, the interfaces of the system has been designed to accomplish this task easily without any hesitation.

3)Application layer

This layer act as the bridge between the client and the database Layer. This layer will do the manipulation of processes according to the given inputs to present the expected output. Functionality, efficiency, accuracy and the productivity of the system is mainly based on the logic which is designed at the application layer.

4)Database layer

This is the layer which does the database management of the system. And also the data storing tactics are determined in this layer. In the new system there is only one database to store all the data regarding the system.

The database is created in a very consistent manner also by applying the concurrency control. In the database all the tables are interconnected with each other properly to make the data manipulations effective and efficient. Both the data entered by the users and the data which is processed by the system are stored in the database.

#### 5)Modular Architecture

This section discusses about how the system is divided into modules and how each module functions. The modularized approach used in designing has ease the development and the maintenance of the system.

#### 6)Login and Authentication Module

Only the authenticated users get the access to the system. After the authentication the accessibility to the system varies according to the user type.

#### 7)Question Submission Module

This module is only accessible by the students. Here the students will submit their question, prioritize the question as low, medium or high according to the time period that they need the answer and also they will select the subject area which the question belongs. Then the system automatically forwards the question to the lecturers who have expertise in the relevant subject area.

#### 8)Solutions Providing Module

This module is only accessible to the lecturers. When a question is forwarded to the relevant lecturers then that lecturers provide the solution for that question. If all relevant lecturers refuse to answer a question within a given period of time, then that question is forwarded to all the lecturers who have been registered in the system.

#### 9)Notification Sending Module

If a student prioritizes a question as high, then that relevant lecturer is notified with an e-mail notification. And also if a question is prioritized as low and if that question is answered within a short period of time then students are notified with an e-mail notification.

#### 10)Answers Rating Module

This module is only accessible by the students. When lecturers post the solutions students get the opportunity to rate those answers by giving stars.

#### 11)Feedback Module

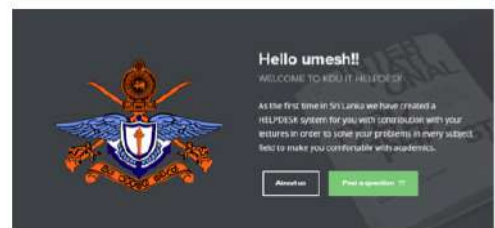
This module is accessible for both the lecturers and the students. Both users can give feedbacks about the system and the services rendered by the system.

#### 12)Previous Question Viewing Module

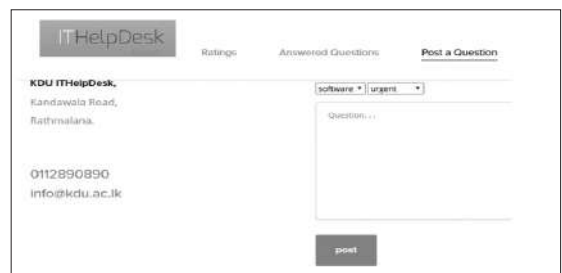
Both the lecturers and students get the access to this module. This module provides the facility of viewing previous questions and the answers.

The developed Online IT Helpdesk system consists of three main interface categorizations, namely interfaces of administrators, interfaces of lecturers and interfaces of students. At the beginning, all three types of users, login to the system by using the same login interface and then the interfaces are visible according to the user type.

Following figures illustrates some of the main interfaces of the proposed solution.



**Figure 3. Welcome Page**



**Figure 4. Posting a Question**

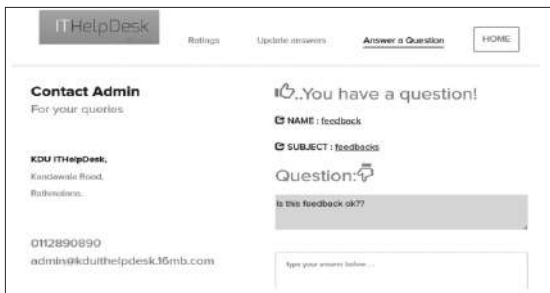


Figure 5. Answering a Question

## IV. RESULTS AND DISCUSSION

An evaluation procedure has been carried out to check whether the system functions properly and whether it meets the expected requirement specifications. For this evaluation purpose a stable system prototype has been used. And it is of utmost importance that this prototype is very much similar to the final product. In the evaluation procedure questions were directly forwarded to the relevant lecturers as expected in the requirements. As an example when a user posted a software based question by selecting the software tag that question was only displayed to the lecturers who has software tag with an email notification. And when the answer is provided by the lecturer then a notification email was sent to the student who posted the specific question. The system was tested using dummy data and the accuracy of the system was 100%. All the mails and question forwarding was done without any errors.

After implementing the system lecturers were able to give comments regarding the answers provided by other lecturers and students were able to give feedbacks about the satisfaction of the given answers. And the lecturers were satisfied with the feedbacks given by the students. User interactivity with the system was 100% and the system helped the students in many ways, like they could ask the questions about their subject matters directly from their department lectures and thereby, they were able to get more reliable answers to clear their doubts. And also each and every student got the opportunity to present their problems to the lecturers. And they could look and search the questions which was asked by other students. When posting a question students' name was displayed along with the question and the lecturer name was displayed when a question is answered and comments were posted anonymously in order to avoid conflicts between lecturers.

Therefore, students were motivated by the system to ask more questions. As a result of that students engaged in more studies and increased their academic knowledge. Finally, this system was accomplished in creating an online academic discussion among the lecturers and the students. When considering the nature of this system it is clear that this system has a more dynamic nature. The system will have to process a number of user requests at once. Therefore, this system can be further developed by using the emerging multi-agent technology. This technology will be able to handle the dynamic nature of this system in a very reliable manner. Therefore, this can be done as a future enhancement for the system.

## V. CONCLUSION

This online help desk system is a novel system which will be implemented in KDU because there is no such system currently available. This system is developed with the intention of helping the students to clear their doubts regarding the subject matters. The main motivation fact that lead us to develop such a system is that, due to the busy schedules of the lecturers and due to the large number of students, the opportunity to solve the problems regarding the subject matters is minimum. There are mainly two types of users who are directly beneficial with the system implementation. They are the lecturers and the students. Because with the help of this system, students will frequently get the opportunity to present their problems to the lecturers from anywhere anytime as this is an online system. And lecturers will get a clear view about the subject matters that they should be more attentive. According to the gathered data, it has become clear that both the students and the lecturers are completely satisfied with the system. Therefore, the entire project process concludes an efficient and accurate development of an online help desk system for KDU based on the collected data. This system is primarily developed for the IT department of KDU. As this system is scalable this can be further developed to cover all the faculties of KDU.

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# AN INFRASTRUCTURE SERVICE SUGGESTION SYSTEM FOR DATA COMMUNICATION NETWORK : LOCAL AREA NETWORK

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**Abstract** - Network Infrastructure development includes building of networks such as LANs, WANs, Intranets and Extranets. This is a responsibility of the Network Engineers or the network architects. They should have the knowledge as well as the skills to plan and design a data communication network, be conscious about the best place to have communication lines, be updated with the latest network equipment and be aware about the hardware and wiring needed for the buildings. These tasks are more complex for larger organizations which needs more accuracy, dedication and flexibility in their networks. Therefore the solution proposed in this paper to reduce these challenges of a network engineer is a Data Communication Network Infrastructure Recommendation System. This system will be able to get any floor plan and analyse it in order to provide recommendations on the installation of the main networking components such as selecting the server room and deployment of the backbone cable. It also allows the user to draft the plan with endpoints by the drag and drop function, keep a log file of the saved data and also to send a System generated network layout of the plan to the customer. The software is being developed by making use of the Image processing technology with the help of the MATLAB Software and C#. A series of algorithms will be used to achieve the objectives of the software. This software is non-identical to current software in the market.

**Keywords** - Network Infrastructure, Image Processing

## I. INTRODUCTION

Data communications is the transfer of computer information from one place to another by using electrical or optical transmission. Such systems are often called data communications networks. A variety of performance requirements and system constraints were considered in the design of the network. . Designing a network consists of tasks such as making decisions about the network type that best fits the needs of a particular organization. In larger sites this task is performed by a senior network architect: an experienced network engineer familiar with both network software and hardware.

According to a business perspective, the organizational commitment is an important characteristic when planning, implementing and controlling an effective network strategy. The organization must be committed to developing an infrastructure that facilitates communication of the business objectives to the network planning team. The organization must also develop internal standards, methods, and procedures to promote effective planning.

Often consultants and outside vendors are needed to help plan and implement the network. However, sometimes consultants are needed to help develop and specify the objectives and requirements. Although outside consultants offer benefits such as expertise and objectivity, they also

present their own set of challenges. The design engineers work according to their own experience.(Tutschku et al., 1997)

These inefficiencies still remain and continue to exist when a network is being designed because once the requirements of the area is given, the network engineer has to use his knowledge to figure out the position of the cables and resources to be used. The ideal network design tool can mean different things to different people. But whether you're a network designer, network manager or engineer, sales or marketing manager, or member of the Research and Development staff, you probably want intuitive graphical interfaces that resemble computer-aided design tools. (Bragg, 2000) A Data Communication Network Infrastructure Recommendation Software is to be developed to eliminate the main inefficiencies of the Network engineer by giving them recommendation to perform the network design. The process of design involves the analysis of user requirements and their translation into a technical solution that is ultimately a compromise resulting from balancing technology against budget. (Linge and Parsons, 2006) It could decrease the complexity of the development of a network in a building or LAN area by giving recommendations to the network design. The importance of this project is not only to the Network engineer as mentioned above but also to the customer company who wants the network to be put up. This project can benefit both these parties, the system helps having a direct communication with the customer as well in forwarding the plan to them just by one click. The system can provide recommendations to set up the network so the engineer has another helping hand to confirm his/her decisions. Before he examine the place he can input the plan and check else he can double check the decisions he made against the system.

Rest of the paper is organized as follows. Section 2 provides a literature review on existing systems of image processing and automated architectural software's and identify the research problem/gap and the possible technology to solve the problem. Section 3 is on the image processing technology used in this project. Section 4 presents the design and implementation and then Section 6 concludes the research findings.

## II. LITERATURE REVIEW

There are many related research papers published related to the architectural plans. These research papers mainly focus on the wall detection of the architectural plans

because it is a main component of a floor plan which can define the whole structure of the building. (Macé et al., 2010)Two different research papers which were focused on analysing the floor plans used the Hough Transform along with vectorization. These two methods were mainly used to detect the lines and room of the floor plan. How this algorithm was defines was according to a certain assumptions which were taken about the walls such as they are thick, they are double lines, longer hat the rest of the line and also rectangular. (de las Heras et al., 2013) According to the paper written by Sebastien Mace, there are there are some drawbacks in using the Hough Transformation such as it's complex nature especially when the images are large. Rooms can also be detected by using semantic analysis. Semantic analysis judges whether the syntax structure constructed in the source program derives any meaning or not. From this process the semantics can be separated in order to find the labels of the detected rooms so we could get the room functions through them. To detect the doors which are represented in an arc shape in the floor plan can be identified using a spotting technique to match the symbol of the door. The Function of the Optical Character Recognitions (OCR) is needed to identify the labels or text characters in the floor plan. OCR can also be programmed in such a way that it can split more than one label to identify the roles of a floor plan. (Ahmed et al., 2012) In order to increase the performance and gain accurate results an approach such as the removal of the components outside the outer walls are used so the functions can focus on analyzing the main components of the floor plan image. (Ahmed et al., 2011) Floor Plans could be analyzed and interpreted in terms of Geometry. According to the Architectural discipline, the building design stage can be categorized into three main process which are the conceptual design process, design development, and construction design. Zimmermann, 2005) During the identification of the parts of a floor plan, identifying a curve can be very challenging. A preprocessing model based on dominant point detector which is associated with the maximum curvature point of an image could be used to segment the curve into straight lines or shorter curves. The dominant point detection process is based on the geometry theories. (Nguyen and Debled-Rennesson, 2011) During very early studies there were methods to segment the lines and arcs such as using the straight line segments as previously mentioned and then fitting those lines to ellipses. These two approaches are being performed with the help of a series of algorithms used to identify steeper curves. (Rosin and West, 1990) A paper has described an algorithm for detecting circular

arcs in arbitrary space curves that result from edge detection in images. A fast algorithm for determining the minimum error match of a circular arc with the data is used. The computational burden is reduced over other curve fitting methods by the constraint that the curve must be bounded by two defined end points.

Although Geometry is an easier method, it might not be the most fast and accurate method. When compared with systems which uses further advancements, according to my opinion geometric is in the initial stages. Using an algorithm to identify the layout of the plan is the best. Two of the methods to input the image of the floor plan to be analyzed can be defined as an input and output method. In the input method, it can be done in real time while the architect is drawing the plan in a device such as a tablet by using structures already available in a drawing tool. If we use an output method, the image could be input as a hand-drawn plan, but if it is hand drawn, the drawing could be unclear and confusing. A digitized image produced by the output method requires high storage capacity, they are also slow in editing. So using an input method is much easier, reduces the time to process along with the storage space. It can also minimize complexities that could arise with the image type compatibility as the image drawn is already given as the needed image format but the architect must have the drawing skills and access to a required computing device such as a tablet which contains drawing tools. (Dosch et al., 2000) However, there are ways which could minimize the errors that could occur in digitized images and they are classified into three sections namely; First being the recognition of lines and shapes which falls under the geometric area, second is identifying the building elements which are walls, doors, etc and the last is about the spatial articulation which is concerned on the space and distribution the objects in the spaces.(Koutamaniss and Mitossi, 1992). Depending on the above analyzed facts, it is most suitable to use the output method as it is a flexible approach to an architect.

Although the above paragraph focuses on the digitized images, this doesn't mean that hand drawn images are not possible to interpret. There have been a number of previous studies on the interpretation of hand drawn floor plans. Hand drawn images tend to have more noise than the digitized images, these are categorized as pixel, vector and context noise. To address these noise in the images we can use Incremental Arc Segmentation Algorithm (Wenyn et al., 2001) Due to the possibility of unclear drawings being input, it is recommended to use various algorithms. During this process the image can be

scanned and vectorized, during this process we can get a graph structure with attributes which can later be used with a graph matching process to recognize the image. Many vector files containing only ASCII-format data can be modified with simple text editing tools. Individual elements may be added, removed, or changed without affecting other objects in the image. It is also easier to render and save the vector data. But still vector files cannot easily be used to store extremely complex images, such as some photographs, where colour information is paramount and may vary on a pixel-by-pixel basis.

Parts of the image such as the walls of the floor plan can be recognized by a filling algorithm. Where the darker, thick areas can be easily identified. This will be used along with a Hough Transformation this identifies the areas without a fixed pattern. (Lladós et al., 1997) These were relatively easier methods with respect to the traditional or manual methods but errors and challenges still remain. Even if these methods were used at some point a human intervention needed to recheck and cover the unidentified errors. (Ryall et al., 1993a) The Hough technique is particularly useful for computing a global description of a feature(s), given (possibly noisy) local measurements.. A sketch based system was proposed to query a floor plan repository along with pre-processing methods such

**Table 1 Literature review summary**

Project	Technique	Software
Scan Plan Project	Hough Transform Vectorization	-
Unsupervised wall detector	Hough Transform Vectorization	CAD
Automated Flow plan Analysis	Segmentation Structural Analysis Semantic Analysis	CAD OCR
Flow plan drafting to building Simulation Software	Geometric	CAD
System for performance evaluation of arc segments	Arc segment algorithm Segmentation	
Data Communication Network Infrastructure Recommendation System	Noise removal Edge detection Filling algorithm	MATLAB C#

as differentiation between thick, medium, and thin lines and the removal of components outside the convex hull of the outer walls. According to this hypothesis, a line of



polygon is selected as wall edge if it is short and is either convex or concave. (Ahmed et al., 2014) Another system is proposed that offers recognition of scanned floor plans (sketched by hand without use of rulers or other tools), and automatic conversion of walls, stairs, doors and other architectural elements. A recognition algorithm was the main solution taken for this problem. Floor plans are read through a scanner while architectural elements are recognized and interpreted automatically, which allows large-scale reduction of input cost. (Shio and Aoki, 2000) According to the successfully completed review of the network infrastructure designing problems, solutions and the technologies, the system which is proposed by this thesis will be developed using Matlab, C# and MySql to address the common problems such as the inefficiencies of the system. Table 1 shows the summarized results. This was decided based on the results of previous research studies.

### III. IMAGE PROCESSING TECHNOLOGY

Image processing involves changing the nature of an image in order to either improve its pictorial information or human interpretation or render it more suitable for autonomous machine perception. We shall be concerned with digital image processing, which involves using a computer to change the nature of a digital image. It is necessary to realize that these two aspects represent two separate but equally important aspects of image processing (McAndrew, 2001).

#### A. MATLAB Software

One of the most advanced and sophisticated tools that is used to analyse and edit images today is MATLAB, it is user friendly with graphical interfaces and anyone without prior knowledge about it can learn about it easily. By using various functions, an image can be edited and analysed by using MATLAB. When it comes to floor plan detection, we can use colour detection, noise removal, converting to grayscale, edge detection and area filling functions. (Buksh et al., 2014) A software was developed by using the main functions of the MATLAB. It was an image editing software where the user can insert the image and perform a series of functions accordingly. A previously proposed image editor contains a variety of image editing functions used by MATLAB with the intention of bring all of them under a single platform so any level of user

will understand it. In a modelling system, a user friendly GUI is developed and two alternative methods for image acquisition are executed. Many experimental examples are used in evaluating the performance of the adopted edge detectors.

The proposed system that this research paper will focus on developing the image processing components by using MATLAB based on the features identified by the already existing software.

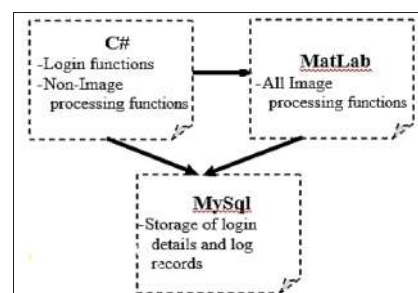
#### B. Secondary Software

Apart from the main language MATLAB which is used for the image processing function, two other technical software will be used to successfully complete the development of the proposed system. They are;

- C# - for functions which does not include image processing functions.
- MySql - For the implementation of the database.

### IV. METHODOLOGY

This section will show how the above technologies are utilized for this ongoing project. Matlab will be used to do all the image processing functions. The image in this scenario is the Floor plan of the building and it will be enhanced, restored and morphological image processing will be done to make the image useful to the network engineer. The Mysql database is used to store mainly the login information and log details of the software so they can let authorized engineers to the customer plans and view log of the saved plans to preserve there integrity. C# is used to view, retrieve and login to the software, basically it is used to operate all other processes that are not related to image processing. Figure 1 shows a diagram of the methodology



**Figure 1 Methodology illustration**

## IV. DESIGN AND IMPLEMENTATION

### A. Description of the proposed system

Data Communication Infrastructure Recommendation System is to be developed to minimize the difficulties of a Network engineer during the design of a network. Considering the problem, it is important to develop a system to facilitate the services needed by a Network engineer in designing a Network in a better manner and overcoming those identified problems in the current manual system. System would be a Data Communication Infrastructure Recommendation System. The system would be built with MATLAB and the main user of the system would be the Network engineer who is responsible for Network design but it can also be used for training of the network engineers. This system will be designed to cover some of the main functions such as the ability for the network engineer to import the plan, selecting the server room where the backbone cable will be auto drawn. An input form could be used to input the bandwidth, topology, etc. Furthermore, when the engineer wants to know the number of routers or switches needed for a particular area, he/she will be able to input the number of endpoints in one floor so the system will generate the number of switches needed accordingly.

### B. Features of the proposed system

Aim of the project is to develop a Data Communication Network Infrastructure Recommendation System to eliminate the above mentioned problems which can make the job of a Network engineer more efficient, fast and easier.

Network Engineer should be able to;

- Import the plan of the building.
- Input the bandwidth, topology, Number of endpoints etc.
- Manually select server room in the plan.
- Send a system generated network layout of a particular area to the customer via mail
- Drag and drop the end points
- Calculate cable distances
- View/Print a report

System should be able to;

- Auto-draw the backbone cable.

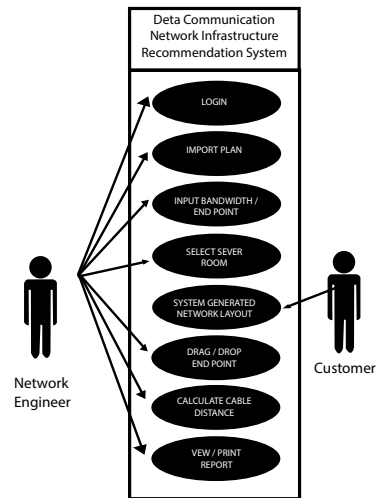


Figure 2 Usecase diagram of the proposed system

After the engineer enters the username and the password, they will be able to successfully access the features of the system. Next the main input being the floor plan of the building will be input by the Network engineers to perform the floor analysis. An input form will ask to fill the bandwidth and the number of end points. The backbone cable will also be auto-drawn according to an input request given by the main user. Via a mouse click command the user is able to select the server room from the floor plan. The outputs of the system are very simple. After the process is being done the engineer can print or view the finished work. If the user wants to clarify the diagram of the structure with a customer feedback, he/she can send a system generated network layout of the finished work with just one click.

According to the successfully completed review of the network infrastructure designing problems, solutions and the technologies, the system which is proposed by this thesis will be developed using MATLAB, C# and MySQL to address the common problems such as the inefficiencies of the system. This was decided based on the results of previous research studies. Figure 2 shows the list of main functions to be performed by the proposed system and the actors or the users of the system along with their relationship with the actions.

**C. Presentation of the application Interfaces**

**a) Welcome Screen and Login screen**

The welcome page for the software which gives an attractiveness works along with Login screen which will be loaded after the progress bar is loaded. Figure 3 shows the developed welcome screen. Figure 4 shows the login screen.



**Figure 3 Welcome Screen**



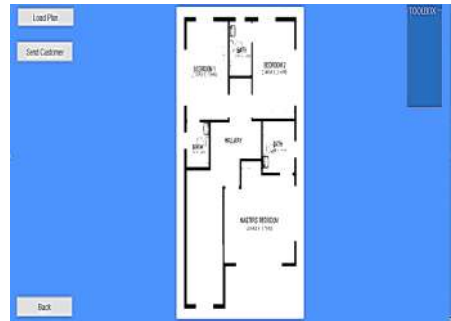
**Figure 4 Login screen**

**b) Image processing form**

This form will contain the import button and other buttons related to the process of the plan of the building. This acts as the main interface of the system.

Figure 5 shows the image processing form with a plan already loaded. The original image of the plan before being loaded is processed into a grayscale image then removed noise by using salt and pepper technique and then the image is turned into binary so that it is easier to identify

the walls from the black colour and the room from the white colour.



**Figure 5 Image Processing screen**

**c) Log form**

This form captures all details about saved data which contains the time, date, who changed it as well as what was changed.

**d) Input details form**

This is a form which will take the inputs of no. of end points, bandwidth, topology, etc for further processing of the image.

**e) Send system generated network layout form**

Once the network engineer press screen shott button this form will appear where he/she will have to enter the customer name so he email will be taken directly from the database.

**V. CONCLUSION**

This paper presents a research to address the main inefficiencies of a Network Engineer when planning, designing and implementing a network infrastructure for an organization because depending on the complexity of the organization structure, a design can be more advanced. This paper proposed a Data communication network infrastructure recommendation system to give best possible options a network engineer could consider the design. The system is being developed by using MATLAB, MySQL and C#. The design and implementation is also presented in this paper.

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# A COMPARISON OF DELTA-COMMUNICATION TECHNOLOGIES AND TECHNIQUES

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**Abstract** - Delta-Communication can be seen as the power of Rich Internet Applications, and there are different Techniques and Technologies available for the development of Delta-Communication, which should be selected carefully into the Rich Internet Application development. Enough discussions are not available, which compare and contrast these Delta-Communication development Techniques and Technologies towards supporting decision making of selecting them. This paper provides an overview of the contemporary Techniques and Technologies available for the Delta-Communication development, contextually compares them aligning to some selected criteria, and finally discusses some facts to be considered when selecting them for the Rich Internet Application development. A literature survey on the Delta-Communication development Technologies and Techniques was conducted, which was followed by a series of experiments towards getting the empirical evidence for the comparison. During the contextual comparison, the Simple Pull Delta-Communication was identified as the least complex technique and the Websocket was noted as the highest complex technology.

**Keywords** - Delta-Communication, Rich Internet Applications, Techniques and Technologies

## I. INTRODUCTION

Rich Internet Applications (RIAs) have become popular with their increased user experience delivered through rich GUIs and faster responses. The key concept behind

the fast responses is the Delta-Communication (DC), which enables the communication of necessary data between the client and the server components, in either synchronous or asynchronous modes, supporting both data-pull and push modes (Dissanayake & Dias, 2017).

There are various Technologies and Techniques (TTs) available for developing the DC in RIAs. These TTs have been already discussed in different forums, and also many tutorials are available to demonstrate the development of them. However, proper comparisons of these TTs are not available towards supporting decision making in selecting these TTs for the RIA development.

This paper gathers contemporarily used DC development TTs, provides an overview of their features, then compare and contrast them aligning to the facts: communication mode, complexity, ease of development, ease of maintenance and modifiability, and scalability. The paper also discusses some facts to be considered, when making decisions for selecting the DC TTs for the RIA development.

For this study, a literature survey was conducted focusing on identifying the available DC development TTs, their features, and development details. Parallel to the literature survey, a series of experiments was conducted towards getting empirical evidence on the identified DC development TTs. During the experiments, prototypes were developed using HTML, JavaScript, jQuery, PHP, and MySQL; and development process and the prototypes

were examined focusing on the complexity, ease of development/maintenance/modifiability, and scalability factors.

Section II of this paper provides the background of the DC, stating some history and the definitions for the DC and related basics. Section III provides an overview of the contemporarily utilized DC TTs. Section IV delivers the contextualized comparison of the DC TTs discussing the results of the comparison. Based on the knowledge gained through the comparison, section V discusses some facts to be considered when selecting the DC TTs for the RIA development. Finally, section VI concludes the paper specifying the future applications of the knowledge delivered in this paper.

## II. BACKGROUND

This section provides some history of the DC concept, and also states definitions for the DC and related basics towards getting an adequate understanding of the concept of the DC before the comparison of the development TTs.

### A. History of Delta-Communication

Microsoft was working on a technology named XMLHTTP in their Exchange 2000 project (Hopmann, n.d.), and it was first introduced to the world as an ActiveX control in Internet Explorer 5.0 in March 1999 (Dutta, 2006) (Smith, 2006); and later it was called the XMLHttpRequest (XHR) object, which has an Application Programme Interface (API) in JavaScript (JS).

In 2005, Jesse James Garrett from Adaptive Path coined the name AJAX, introducing the first JS based DC technique for the web applications, utilizing the XHR object (Garrett, 2005). This technique became popular and took the traditional web applications to a whole new era called Web2, which is the era of the RIAs. Later W3C acquired the control of the XHR object and released the first specification on 2006 (W3C, 2006). Since then the term AJAX has become another name for the RIAs, where even some developers refer the RIAs as AJAX applications.

AJAX can be seen as the beginning of the JS based RIA development approach, and it became a major breakthrough in the web development area (Salva & Laurecot, 2009). After its introduction, developers were learning how to use AJAX to create desktop-like

GUIs in the web applications such as Google Maps; and later they subsequently used AJAX even to create entire enterprise RIAs (Lawton, 2008). Using the JS's ability to manipulate the Document Object Model (DOM) in HTML documents, AJAX achieves and enhances the interoperability capability of the web applications (Salva & Laurecot, 2009).

It should be noted that the AJAX itself is not a technology, it is a technique; and the technology behind AJAX is the XHR object with its JS API. The AJAX is a data-pull technique, employing the traditional request-response model. Combining HTML and CSS with JS, AJAX has become a powerful tool in RIA development, providing the fundamental implementation of the DC.

The main characteristics of AJAX and other DC TTs introduced after AJAX, are discussed in section III.

### B. Definitions for Delta-Communication and Related Basic Concepts

Before discussing the DC TTs, it is important to understand what the DC is, its characteristics, and also related basic concepts.

The main features of the DC are the capability of processing in the background and then performing partial page rendering to display the results on the GUI (Dissanayake & Dias, 2017). The communication is done faster due to the smaller set of data communicated compared to the traditional web communications. Considering these facts, the DC is defined as: "Delta-Communication is the rich communication model used by the rich features of the RIAs, for client-component(s) to communicate with the server-component(s), to exchange only the needful dataset – for a particular feature executed at the time – which is smaller, compared to the size of the request/response of traditional communication. Since the size of the dataset communicated is smaller, the communication completes faster, eliminating the work-wait pattern. The processing of the response is done by the client-components in the background, therefore the page refreshes are eliminated and replaced by partial page rendering to update the content of the GUI with the results of the response. The user experience can be determined by the implementation of the feature, in either blocking (synchronous) or non-blocking (asynchronous) modes" (Dissanayake & Dias, 2017).

Simple Pull Delta-Communication (SPDC) is the simplest abstract implementation of the DC, and it is defined as: “Simple Pull Delta-Communication is the basic abstract Delta-Communication technique, based on the data-pull mode. It describes the simplest form of data-pull Delta-Communication, based on the request-response model; and this technique is technology independent” (Dissanayake & Dias, 2017).

Aligning to the definition of the SPDC, AJAX technique can be seen as JS implementation of the SPDC, which is limited to the browser based applications. The term AJAX expresses some flaws, and it is outdated with regards to the latest API version of the XHR object (Dissanayake & Dias, 2017). Due to the evolution of the XHR object, the technical scope of the AJAX has been expanded in terms of both XML and Asynchronous aspects. Based on these facts, considering the outdated and limited impression of the term “AJAX”, it can be replaced by the term “JavaScript-based Simple Pull Delta-Communication” (JS-SPDC) (Dissanayake & Dias, 2017). The term JS-SPDC indicates that it utilizes the SPDC technique, and developed using JS.

### III. TECHNOLOGIES AND TECHNIQUES FOR THE DELTA-COMMUNICATION

After the introduction of AJAX/XHR, the concept of the DC had been used in some other TTs, and each TT is associated with a set of pros and cons. These DC TTs can be mainly classified under data-pull and data-push modes, where the data-pull is based on the request-response model, which the client requests and pull the data from the server; and in the data-push, the server sends data to the client without a request. This section provides an overview of the available DC TTs, indicating their main features. In-depth discussions of the specifications of these TTs are intentionally kept out of the scope of this paper. Instead, the focus is to classify them for a better understanding of their usage, to be utilized in the comparison given in the next section.

#### A. AJAX/JS-SPDC

As discussed before, the AJAX can be seen as the simplest implementation of the DC. It is based on SPDC, works in data-pull mode, and the complexity is comparatively lower than the other DC TTs. The main limitation of the SPDC technique is that it does not support data-push mode; therefore, it is not suitable for real-time data communication as in publisher-subscriber model or any other data-push models.

Several techniques had been introduced to simulate data-push using SPDC; some of them – like polling and long-polling – use the same XHR object, thus also called reverse-AJAX.

#### B. Polling (Carbou, 2011)

In polling, data-push is simulated by sending automatic XHR requests to the server periodically, receiving the response for the frequent requests, and updating the GUI, without the users’ explicit requests. There is an overhead of developing periodical requests sending and responses handling. If the frequency of the requesting is low, then the server updates will not be received by the client in real time. To get the updates in real time the frequency of the automatic request sending needs to be higher, but then the network overhead will also be higher. In the cases of where the requests are returned without updates, the resources for processing them are wasted. Addressing these weaknesses of polling, the Comet techniques had been introduced.

#### C. Comet (Carbou, 2011)

Comet is an umbrella term, which covers Streaming and Long Polling. In Comet techniques, unlike polling, the request is held by the server till there are updates to be sent back to the client. In the case of timeouts, the request is terminated, and the client can send a fresh request. This technique reduces the frequency of the requests, thus, also reduces the overhead on the network compared to polling.

1)Streaming: Under streaming, there are two implementation techniques: Hidden iFrame, and Multi-part XHR. In former technique, JS scripts are pushed to the client, and in later technique, a multi-part response is written via the same connection, which the request was sent.



2) Long Polling: Long polling uses the pure SPDC technique as in AJAX and polling, which holds the request for longer time. Compared to streaming, this technique can be seen as evolved and effective.

**D. Server Sent Events (Hickson, 2015)**

On 2015, a true data-push protocol named Server Sent Events (SSE) was introduced, which is unidirectional, from the server to the client. However, it did not become much popular. Compared to data-push simulation techniques, the complexity is lower, and the development and modifiability are easier since the development overhead for data-push simulation as in polling or long polling is not needed.

**E. WebSocket (Fette, 2011)**

An advanced bi-directional DC protocol named WebSocket (WS) was introduced in 2011, which supports both data-pull and data-push modes. WS helps to reduce the number of request-response pairs in the network compared to polling, and the header size of the WS is smaller than HTTP, which leads to increase the scalability by addressing the C10K problem (Kegel, 2014) compared to the other DC TTs. The WS gained the attraction of the web engineers, however, the complexity of WS applications is higher.

**IV. COMPARISON OF SOME PROPERTIES OF DC TTs**

Table 1 contains the analysis of the contextualized comparison of some selected properties of the DC development TTs. The meaning of the symbols used to denote the values are as follows. Note that these values are comparative to each other, within the context.

- (++) – Higher
- (+) – High
- (-) – Less
- (--) – Lesser

The factor “Core” indicates the abstract technique or the technology used in the core of the technique or the technology. The mode explains whether its data-pull, push, or simulating either push or pull. The data-push simulating TTs (which are actually working on data-pull

mode) use the SPDC as their core technique, where SSE and WS use their own protocols.

The complexity is determined by the comparative complexity of the DC implementation, considering the number of components needed for the development of the communication components. SPDC is the simplest form of DC, hence can be considered as the least complex technique. As the extended versions of the SPDC, the TTs such as Polling and Long-polling can be considered as much complex. Though the SSE is a data-push technology, since it is unidirectional, the complexity can be considered as similar to SPDC.

**Table 1. Comparison of some features of DC TTs**

	JS-SP-DC	Polling	Streaming	Long Polling	SSE	WS
Core	SPDC	SPDC	SPDC / hidden iFrame	SPDC	SSE protocol	WS protocol
Mode	Pull	Push simulation	Push simulation	Push simulation	Push	Pull and Push
Complexity	--	+	+	+	-	++
Easiness of Development	++	-	-	-	+	--
Easiness of Maintenance / Modifiability	++	-	-	-	+	--
Scalability	+	--	-	+	+	++

However, the SSE does not need additional components for simulating like in polling or comet, thus can be seen as less complex compared to them. As a bidirectional technology, the complexity of the WS can be seen as the highest. Additionally, WS based development requires additional code and components for WS server implementation and event handling, which makes the development is much complex.

The complexity directly affects the easiness of developing the DC, and also the maintenance and modifiability properties of the system. As the simplest DC technique, SPDC provides the easiest development experience, compared to the other TTs, where WS offers the least easiness as the much complex bi-directional DC technology. Note that this is the comparative easiness of developing a single DC feature, not the actual easiness of the development of the entire system. The comparative easiness of the maintenance and modifiability properties could be a similar to the easiness of the initial development.

For the scalability property, the scalability of the system towards real-time communication based on publisher-subscriber or similar model is considered. For such scenarios, WS offers the capacity to provide the best

scalable solution, addressing the C10k issue (Kegel, 2014). JS-SPDC has no mechanism for higher scalable development; however, note that if real-time updates are not needed and if the frequency of the network utilization is less, JS-SPDC can also provide higher scalability. With the frequent redundant requests and responses, polling shows the lowest scalability. Long polling and SSE provides moderate scalability, and considering the higher size of the data communicated the scalability of streaming can be considered lower than long polling and SSE.

## V. FACTS TO CONSIDER IN DECISION MAKING OF SELECTING TTs FOR RIAs DEVELOPMENT

Several important facts to deliberate when making decisions about selecting TTs for the implementation of DC are discussed below (Domenig, n.d.).

**Stakeholders' constraints:** Stakeholders of the system may have technological constraints such as operating systems, servers, database management systems, etc., based on their available infrastructures and resources. The selection of the DC development TTs may need to align to such constraints since most DC developments are based on frameworks/libraries/plugin-ins. For example, if there is a requirement for WS and the stakeholder needs a JAVA based system, a suitable JAVA based framework for WS development should be considered.

**Compatibility:** The compatibility of the TTs selected for all the client-components, server-components, and DC components is really important. Selection of a TT for one component may affect the TTs of other components, therefore may introduce additional learning curves, and also may introduce limitations for selection of TTs for other components. For example, if WS is selected for DC, for both server and client components, additional frameworks/libraries might be needed, and they should be compatible with each other.

**Scalability:** The size of the target user population and number of concurrent users (approximate) are the facts to consider when determining the scalability. Scalability plays a significant role when selecting TTs for client-components and DC. If a higher scalability is needed, it

is recommended to select WS, regardless its complexity. **Real-time updates:** If real-time updates are needed, it is wise to select the DC TT by also considering the scalability. However, to get the true power of the real-time data communication, WS can be seen as the best option. Furthermore, suitable data formats like JSON should be considered to get the maximum support for real-time critical systems (Dissanayake, et al., 2015).

**Development, maintenance, and modifiability:** The easiness of not only in the initial development, but also in maintenance and future modifications may also take into account. Table 1 contains the easiness in development, maintenance, and modifiability. Correct identification of the scalability requirements is essential, before considering the maintenance and modification aspects.

## VI. CONCLUSION AND FUTURE WORK

The paper has given an overview of the contemporary DC development TTs, and then has done a contextualized comparison aligning to the facts: communication mode, complexity, easiness of development, easiness of maintenance and modifiability, and scalability. It was identified that the AJAX/JS-SPDC is the simplest implementation of the DC, which incorporates the lowest complexity; however, it lacks in scalability. JS-SPDC is limited to data-pull, thus it does not support data-push. The WS covers the limitations of the other DC TTs like scalability, support for both data pull and push. However, the complexity of WS is seen as the highest among DC development TTs.

Aligning to this comparison, the paper has discussed some facts to be considered in the decision making of selecting proper DC development TTs into RIA development: stakeholders' constraints, compatibility, scalability, need for real-time updates, and the easiness in development/maintenance/modifiability.

In future, we expect to exploit the knowledge delivered in this paper to introduce a taxonomy for the DC development TTs for RIAs. Then we hope to extend that taxonomy to introduce a complete set of taxonomies for RIA development TTs aligning to the architectural elements: Components and Connectors.

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