15TH INTERNATIONAL RESEARCH CONFERENCE

Economic Revival, National Security, and Sustainability through Advancement of Science, Technology, and Innovation

29TH - 30TH SEPTEMBER 2022

COMPUTING

PROCEEDINGS

GENERAL SIR JOHN KOTELAWALA DEFENCE UNIVERSITY

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General Sir John Kotelawala Defence University
Ratmalana, Sri Lanka

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Welcome Address

Major General Milinda Peiris RWP RSP VSV USP ndc psc MPhil (Ind) PGDM
Vice Chancellor, General Sir John Kotelawala Defence University

Chief Guest, Secretary - Ministry of Defence, General Kamal Gunaratne (Retd), Keynote Speaker, Hon. Prof. Subramanian Swamy, Your Excellencies in the Diplomatic Corps, Chief of Defence Staff, Gen Shavendra Silva, Commander of the Army, Lt Gen Vikum Liyanage, Commander of the Navy, Vice Admiral Nishantha Ulugetenne, Eminent plenary speakers representing our friendly nations, Vice Chancellors of Other Universities, Former Commandants of KDA, Former Chancellors and Vice Chancellors of KDU, Rectors of KDU Campuses and Deputy Vice Chancellors, Deans of Faculties and Centre Directors, Senior Military Officers and Police officers, Academics, Administrative Staff, Students, All distinguished guests including those who connected with us in the cyberspace, Ladies and gentlemen, Good Morning to you all! I am deeply honoured to make the welcome address at this inauguration of the 15th International Research Conference (IRC) of General Sir John Kotelawala Defence University. To begin with, I warmly welcome our chief guest this morning, Gen Kamal Gunaratne (Retd), Secretary to the Ministry of Defence for gracing this important occasion. We owe you a great deal of respect for the whole-hearted support extended for the progression of this university at all times. Also, may I have the distinct honour of welcoming our keynote speaker, the esteemed and renowned personality, Hon Prof Subramanian Swamy from neighbouring India.

Hon Sir, we are extremely grateful to you for accepting our invitation and honouring us with your gracious presence to deliver the keynote address of this two-day international research conference. I am sure that your eminent presence adds great value to the event, and we are looking forward to listening to your words of wisdom, which will surely set the most appropriate tone for this scholarly event.

I also welcome the Chief of Defence Staff, Gen Shavendra Silva, Commander of the Army, Commander of the Navy and all other members of our Board of Management. Let me also warmly welcome the members of the Diplomatic Corps representing our friendly nations, Vice Chancellors and Senior Academics from other universities, Former Commandants of KDA, Former Chancellors & Vice Chancellors of KDU, Other officials of Ministry of Defence, Academics, Senior Military Officers, Plenary speakers, Scholars presenting papers in this two-day conference, and all other distinguished invitees and students joining this event physically as well as on cyberspace. As the Vice Chancellor of KDU, I admire your valuable presence at this occasion.

Reflecting on KDU IRCs held last year and the year before, we held them under the most trying circumstances of the grave pandemic. They really tested our resilience and

defiance against challenges to the very core. Along with the IRCs, we determinedly continued with all academic and other activities of the university with much vigor, and the results are evident in our achievements.

Ladies and gentlemen, today, we are glad that KDU has firmly established its foot print as a unique higher educational model in the world, which even its critics would not be able to disagree with. The best evidence is its steady growth in its popularity as an Higher Education Institute in Asia, as well as the quality of its output, which are evident in the Times Higher Education Impact Ranking, 2022 table, where KDU is ranked 2nd in Sri Lanka for Quality of Education and 4th in the overall ranking in the country and in the 801-1000 range globally. A more recent indicator of our growth is evident in the world ranking of Law Schools, where the KDU faculty of law took a leap in the world ranking from the 498th place in 2021 to the 83rd place in 2022, from the 189th place to the 25th place in Asia, and from the 5th place to the 2nd place in Sri Lanka.

Ladies and gentlemen, today, we hold the 15th consecutive IRC at a time when we, Sri Lankans are in a grave need to pull up our socks as a nation to face the seemingly unsurmountable economic crisis we are in. And we as a university are determined to give our utmost best for the nation at this crucial juncture.We believe that the role of the universities and the intellectual community of the nation is of paramount importance for the resurrection of our economy, and that of the nation's defence university is even more significant as it deals

with the national security perspective which is inseparably linked with the economic crisis and with a possible recovery from the same.

Serious research in defence and security studies needs to go hand in hand with rigorous research in all other fields. This, we believe, is an essential prerequisite for a quick and sustainable recovery from the crisis. So, we carefully selected the overarching theme, *"Economic Revival, National Security, and Sustainability through Advancement of Science, Technology, and Innovation"* for this year's conference, and its scope encompasses a wide range of significant research possibilities to engage in.

Our aim in selecting this theme entails a holistic vision of the complexities of economic and national security perspectives which demand comprehensive inter- and multidisciplinary approaches to resolve contemporary issues. The expectation is to carry forward the research outcomes to the attention of those in authority to consider implementation to resolve related issues. I do not intend to talk any further on this aspect as I am sure our keynote speaker would elaborate on the conference theme and its significance. Ladies and gentlemen, having commenced in the year 2008 in a humble way, the KDU IRC gained gradual momentum as a trustworthy forum for the country's scholarly community to showcase their multi-disciplinary research outcomes. And what is noteworthy is the ever growing increase in the number of research papers submitted for the conference, and more so is

the increasingly higher quality of the papers presented at the conference.

Therefore, KDU enjoys the humble pride of its leading role in strengthening the research culture in the country that is more and more inclined towards product based or problemsol ving outcomes in relevant fields, which I believe is the need of the hour. Also the involvement of internationally collaborative research is on the increase. Anyone who visits the KDU IRC Proceedings would note the evolutionary path of the progression in research in the country spearheaded by KDU – You could see the increasingly high numbers of researchers representing almost all the universities, other Higher Education Institutes and research institutes of the country as well as those from renowned universities, Higher Education Institutes and research institutes in the world. So, we are proud of our role in establishing local and international research and scholarly networks that would further enhance creation of new knowledge in diverse disciplines and dissemination of the same.

Ladies and gentlemen, the organizers of this year's research conference too have been doing their utmost best to maintain and upgrade the quality of the annual research conference despite challenges, especially in the face of financial constraints which compelled them to significantly cut down on peripheral expenses.

The circumstances have compelled them to rely on our own resources as much as possible, which I believe is a blessing in disguise in the crisis situation to convert challenges into opportunities. I appreciate their effort and the support extended from all quarters to make the KDU International Research Conference a resounding success in terms of achieving its objectives. So, let me conclude by once again welcoming our chief guest, the erudite keynote speaker, and all the other distinguished invitees. I convey my congratulations to all researchers who will be presenting their research during the couple of days.

I also request those whose papers were not selected through the double blind reviewing process not to get disheartened because you had competed with many for a placement in the conference. Finally, let me express my heartfelt thanks to the Chairman of the Conference Organizing Team, Dr. Kalpa Samarakoon, Secretary, Dr. Pandula Athawuda Arachchi and the other members of the team for the tireless hours, days and weeks you spent to see the success of this important event.

May the KDU IRC be a haven for establishing scholarly links at national and international levels, which would pave the way for fruitful research, academic and even industrial collaborations for the betterment of our nation, its security and its social, economic and political stability that would in turn pave the way for the creation of a self-sufficient nation in the not so long future. Let us optimistically believe in ourselves and in our potentials to reach that target sooner than later.

Thank you.

Chief Guest Speech

General Kamal Gunaratne (Retd) WWV RWP RSP USP ndc psc MPhil
Secretary - Ministry of Defence, Sri Lanka

Hon. Prof. Subramanian Swamy, Keynote speaker of the 15th International Research Conference 2022 of General Sir John Kotelawala Defence University, Your Excellencies in the Diplomatic Corps, Chief of Defence Staff, Commander of the Army, Commander of the Navy, Chief of the Staff of Sri Lanka Air force, Vice Chancellors of Other Universities, Vice Chancellor of KDU, Eminent speakers from friendly foreign nations, former commandants of KDA, former Chancellors and Vice Chancellors of KDU, Rector of KDU Metropolitan Campus, Rector of KDU Southern Campus and Deputy Vice Chancellors, Deans of Faculties and Directors, Senior Military Officers and Police officers, Distinguished guests, Ladies, and Gentlemen's. Good morning to all of you.

I consider it as a great pleasure and privilege to be present here today as the chief guest of the inauguration ceremony of General Sir John Kotelawala Defence University's International Research Conference, which is taking place for its 15th consecutive time.

Without a doubt it provides as opportunity for academics, professionals, researchers and practitioners from all around the world to share their research findings and expertise addressing mutual challenges in their fields. Further it provides an opportunity for a wide interaction and networking with national and international scholars in respective fields which in turn proved beneficial for the

participants to broaden their horizons of knowledge through intellectual discussions most importantly despite the global pandemic situation and the reason economic, social and political setbacks in effect it is truly inspiring to see that the KDU is continuation the conduct of this conference with renewed spirit and commitment

Therefore, ladies and gentlemen at this moment I would like to encompass
My sincere appreciation to the Vice Chancellor and the conference organizers for the invitation extended for me to be the chief guest to the most significant academic events of this University. In this context of promoting an excellent academic culture generation of knowledge and subsequent applications of it led to innovations and novel technologies that are crucial for the advancement of humanity, well-being, and sustainability. The knowledge is generated by scientific research and at this backdrop, it is delightful to see that the theme of this year's conference reads economic revival, National Security, and Sustainability through the advancement of Science, Technology, and Innovations, which is a well-timed theme reflecting directions that we should pursue as a country irrespective of the boundaries of time and era.
Further, at this moment, ladies and gentlemen, I will be failing in my duty if I do not acknowledge the distinction of a brilliant keynote address conducted by the former Minister of Commerce Law and the Justice

Republic of India, Honorable Professor Subramanian Swamy. Sir, we as Sri Lankans truly appreciate the accept acceptance of our invitation extended to attend and maintain throughout the past in continuation of the display of your friendliness towards Sri Lanka. The ideas that would be shared by you in this eminent forum today will indeed bring a sparkling light to the discussions to be conducted during this conference that will become highly fruitful with your intellectual input.

All the foreign and the local participants including the senior officers od tri-forces and police would be immensely benefited by the inputs that would be given by you to broaden the Horizon of their knowledge.

Moving on the the focus of the conference I must emphasized that with the effects of globalization in effect the growing international independencies affecting the Sri Lankan National security as well as reasons concerns raised by economic and political implications. There is a recognized need for assessment of the potential to national security, that may emerge during the thrive towards revival of national economy and sustainability.

As per my belief given the importance of certain sectors to the effective functioning of the Sri Lankan society the said need for a deeper conceptual understanding of the threats that may impact the implied economic revival and sustainability in all aspects focusing on technological scientific and innovative faces would be comprehensively discussed with in the earnest gathering of intellectuals during these two days.

A strategic standpoint keeping the past and also most recent lessons learned
In mind a newfound leadership of the present government, Sri Lanka should call for national determination where all sectors of Sri Lankan society including civil organizations, security institutions, political entities and business associations come together to discuss fundamental issues such as national identity, national reconciliation, transitional justice, governance structure, economic revival and many more.

This is a fundamental step towards building consensus and religious legitimizing state institutions and private organizations in the country towards a common goal. Not only would such an effort-based process serve as the foundation for a national pact addressing the country's issues, pointing out how it would concurrently compel every group in society to work towards state building and the sustainability of a secure country due consideration to scientific and technological innovations.

Furthermore, giving high priority to providing solutions to the country's most freezing matters of concern to improve the world's image of Sri Lankans society the Sri Lankan government must take every step necessary to recover high-priority initiatives in the fields of the economy, institution-building, and political reform.
Whilst giving true meaning to the said initiatives in order to address emerging challenges promoting more research and development becomes a task of topmost priority bestowed upon all of us who are present here today.
Fortunately, as a secretary Defence and the Chairman of the KDU Board of Management, I

feel tremendously proud and content to state that KDU is at the forefront of researching the development and security related problems holistically.

In this context, one of the unique aspects of KDU IRC in comparison to s plethora of symposia that we witness in the country and beyond its borders remains to be its firm commitment to defence and strategic aspects of the contemporary world with emphasis on local and regional trends.

In that this conference continues to pioneer in upholding the notion that security is a prerequisite for the viability of achievements in all other areas in which mankind relies on in order to facilitate such outcomes it maintains a seamless association of defence and security with other core areas such as Sciences, Medicine, Engineering, Build environment and Spatial Sciences, Technology, Management, and Huminites. We are fundamental knowledge images. To be honest, I personally acknowledge this pragmatic philosophy as a remarkable achievement of KDU and thereby of the country as a whole. Resulting in interactions and dialogue across apparently distinct disciplines will certainly usher increasing exchanges and collaborations among experts in diverse areas, therefore, I am well certain that all faculties of Sir John Kotelawala Defence University with their interest and commitment to knowledge in diverse academic disciplines and outside researchers' inputs would contribute immensely to this year's research conference theme.

The knowledge that you are giving to another and sharing during this conference would be an immense benefit not only to the academic community but to the entire humankind to make their lives better.

In conclusion, ladies and gentlemen, at the current context we are on the average of striving to accomplish serenity and excellence in an economic revival, national security, and sustainability through unexploited frontiers of technological innovations as a nation. Therefore, conferences of this nature are instrumental in clearing our fond of mind for the betterment of establishing solutions, therefore, let me express my sincere appreciation to the Vice Chancellor and organizers of the 15th KDU IRC 2022 for inviting to this occasion as the chief guest and giving me an opportunity to speak to you. Let me appreciate all the efforts and congratulate all of you for working your way towards a timely and appropriate theme. Finally, I wish all the participants all the very best in their research endeavors and the KDU research conference for 2022 to be successful in every way.

Keynote Speech

Hon Prof Subramanian Swamy
Former Minister of Commerce, Law & justice, India

Hon. Professor Subramanian Swamy, former Cabinet Minister of India made insightful remarks in the keynote address and initiated his speech by extending his gratitude towards Vice chancellor Major General Milinda Peiris for the invitation bestowed on him and went on to acknowledge the presence of the chief guest, Secretary to Ministry of Defence, General Kamal Gunaratne stating, how the Indians themselves couldn't put an end to a major terrorist problem in the region. Professor Swamy recollected how Sri Lanka has never been defeated throughout history, exempting a few setbacks. Furthermore, Professor Swamy remarked how the 21st century isn't going to distinguish between large nations and small nations, as it's a new era with innovations. Speaking from his experience as a trained economist, Professor Subramanian Swamy recalled how all economic development took place when the share of innovation calculated within the GDP rounded up to at least 55%, indicating the development of the USA, Europe and China as examples. He explicating further, mentioned that the growth rate of GDP would be dependent upon the extent to which one innovates. Professor Swamy also recognized the role that could be assumed by the universities in the development of the concept of innovation.

Professor Swamy, elaborated on the inception of the definition of – National security relating to its historical context. He expressed that for most of the 20th century national security had been a matter of military power, and explicated with the dawn of the 21st century, non-state actors posed most of the challenges to national security as opposed to conventional military warfare. Moreover, professor Swamy emphasized that long-term unsustainable practices make the state more vulnerable to internal and more resilient to external threats. Professor Swamy pointed out the "economic factor "as the primary reason behind Sri Lanka's recent upheaval. Furthermore, he scrutinized the removal of democratically elected people from office, which in turn would disallow them to complete their full term, which he recognized as a blow to the country's national security.

Professor Swamy detailed important aspects that need to be regarded in policy formulation; clearly defined structure of objectives, the order of priorities, strategy to achieve them, and resource mobilization. He also stated that no country should be too dependent on one country, and pointed out how Sri Lanka owes a single country, a staggering 52% in internal and external debt. He further resonated that the world has moved from the notion of "development" to "sustainable development", "sustainable economic development and sustainable national security" during the course of the last thirty years of the 20th century. Professor Swamy asserted that the most stable system of governance is democracy. Furthermore, he perceived economic security, political security, energy security, homeland security, and new

technology and innovations to be primary elements that constitute sustainable national security. Honourable professor Subramanian Swamy concluded his speech by stating that the sustainable national security of a country is the ability to provide comprehensive protection and holistic defence of citizenry and climate change, other issues of globalization, terrorism and many more.

Vote of Thanks

Dr Kalpa W Samarakoon

Conference Chair, 15th International Research Conference,
General Sir John Kotelawala Defence University

The Chief Guest, General Kamal Gunarathne, Secretary to the Ministry of Defence, The keynote speaker, Hon Prof Subramanian Swamy, Chief of the Defence Staff, Commander of the SL Army, Commander of the SL Navy, The Representative of the Commander of the SL Air force, The Vice Chancellor of KDU, The Rector KDU Southern Campus, The Rector KDU Metropolitan Campus, The Deputy Vice-Chancellor (Defence & Administration), The Deputy Vice-Chancellor (Academic), Deans of Faculties, Directors, Senior Professors, Senior Officers of tri-officers, and Police, Distinguished invitees, Colleagues, ladies, and gentlemen. Good morning!

Sri Lankans have been suffering an economic slowdown in the post covid era, in particular, with a social and economic crisis, food insecurity, and inequitable provision of health and education, due to its over-reliance on traditional exports, tourism, and constant geopolitical battles. In this context, KDU has been successful in organizing its 15th consecutive International Research Conference. We, strategically analyzed the role of academia of the country to collectively come together and facilitate the transfer of knowledge, skills, and solutions using science, technology, and innovation.

The IRC theme selection for 2022, aims to provide a multi-professional platform to all the scholars based in Sri Lanka and overseas to bring in their innovative research ideas to fulfil this national responsibility thrust upon us, to revive the nation's economy, to achieve sustainable economic growth coupled with an environment of justice and enhanced security for all. This year's conference attracted more than six hundred and ninety paper submissions in 11 sessions the highest-ever submissions since the inception of IRC. This indicates the amount of novel knowledge generated in our country. This year is the conference's inaugural technology and criminal justice sessions.

With deep appreciation and gratitude, I would like to express my heartiest thanks to General Kamal Gunaratne, the secretary to the Ministry of Defence who is our Chief Guest today at KDU-IRC 2022. Sir, your gracious presence in this occasion despite other commitments is truly appreciated and encouraging, and it has certainly added glamour and value to this important event on the KDU calendar. The same goes with Hon. Prof. Subramanian Swamy. He is a renowned academic and has been a distinguished politician in India and even beyond. Sir, I greatly appreciate your willingness to be our keynote speaker. It is truly an honour, privilege, and inspiration to witness your presence among the KDU community today.

I would like to take this opportunity to express my heartfelt gratitude and deep appreciation to the Vice Chancellor of General Sir John Kotelawala Defence

University, Maj. General Milinda Peiris, with your leadership, guidance, and timely decisions, prevailed throughout the event organization. The event would not be bound to be a success without your active input, particularly under the current difficult context. Thank you indeed Sir.

I will be failing in my duties if I didn't acknowledge the crucial involvement of KDU Deputy Vice-Chancellor (Defence and Administration), Brigadier W. Chandrasiri. He in fact steered KDU-IRC 2022 organization effort providing correct and pragmatic directions successfully even when the team was at difficult crossroads. I would also like to thank the Deputy Vice-Chancellor academic and all faculty Deans and Directors, who held the responsibilities for organizing and conducting forthcoming academic sessions.

Ladies and Gentlemen, as I said before, It has been a seemingly overwhelming challenge to organize, coordinate and conduct a research conference of this magnitude at this time.

I must appreciate the support of our sponsors. Platinum Sponsors, together with banking giants namely, Bank of Ceylon, People's Bank, and special sponsors, Gamma interpharm and George Stuart Health.

 Let me take this opportunity to thank generously, conference secretary, Dr Pandula Athaudaarachchi, Senior lecturer and consultant interventional cardiologist, and the tremendous work done by the three co-secretaries, Dr. Gihani Jayaweera, Lt Col Lasitha Amarasekara and Ms. Sandali Goonathilaka, who stood alongside me ever since work has been commenced in mid of 2022 with exceptional commitment. I also

thank all the session coordinators who supported tirelessly around the clock from the moment. I am certainly indeted to them for the success of KDU-IRC 2022.

I deeply appreciate all the presidents of the committees, and committee members, faculty committees, Office of Vice-chancellor, Office of DVC, officers of Bursar, Officers of the registrar, Adjutant, co-admin who held and executed the roles and responsibilities over the IRC. A special thank goes to the media and communication team led by the Director of IT, Publishing, printing and editorial committees.

I take this opportunity to thank all authors who shared their valuable research works at KDU-IRC. I thank both internal and external reviewers who perused and evaluated the submissions. Please be assured that your expertise shown and valuable time spent in critical reviewing is duly appreciated.

An event of this dimension cannot happen overnight. The wheels start rolling months in advance, it requires meticulous planning and execution and an eye for details. I cannot thank everyone enough for the involvement they have shown, So please bear with me if I would not have named all the supporters.

I expect that participants of the two-day conference that commenced just now will have an occasion that broadens their horizons of own know-how and improve networking in a refreshing environment which all of us at KDU has attempted to facilitate.

I wish you the very best at the conference.

Thank you very much!

COMPUTING

PLENARY SESSION

The Enablers and Inhibitors of Digital Transformation

Prof Janaka Wijayanayake

Professor of Information Technology, Department of Industrial Management,
University of Kelaniya, Sri Lanka

The world is changing, so is the world changing very fast, digitally. If you look at Big Data, according to the data available, 90% of the data was created during the last two years. Technology is the enabler of digital transformation. In 2021 itself. 1.3 billion+ Smart devices were shipped, and when comparing to that of the world population which is 8 billion, that is a big percentage of smart device usage per person. Social networks are also very interesting to consider. During the year 2020, 2.14 billion + Customers or more had basically taken some kind of advice in purchasing their goods through social networks. More than 450 Billion USD were spent by end users for Cloud Computing services in 2021 itself.50 billion devices are connected to the Internet by 2021. The API economy, another factor that drives digital transformation surpassed its worth value of One Trillion USD by the end of 2021. These are some insights from the past. How would the future be? According to the statistics of Bloomberg, by 2029, there will be 20% of compound annual growth rate of smart devices. Then what about Sri Lanka? Actually, it's very difficult to find data related to Sri Lanka and digital transformation. But I managed to find statistics published by McKinsey and Company in 2018. According to the digital maturity index, we have scored 35 points

out of 100, but it's not encouraging. With this in. Mind, we'll see what digital transformation is. Actually, there is no specific definition for digital transformation because. because digital transformation vary from one organization to an organization, industry to industry, country to country. So therefore you can't pinpoint and say OK, this is what the digital transformations. But for this presentation of course I selected one which covers. All the aspects of digital transformation. So according to that digital transformation is the integration of digital technologies into areas of a business. So all the areas of a. Fundamentally, changing how your operations are delivered, value to customers. It also cultural change that requires organization to continually change the status quo experiment had got get comfortable with failures, so the main points are. So it is. All the areas of business, right? And then of course. You need to change how the things operate and it is not only technology, it is a cultural change as well. So just by introducing digital technology you can't achieve digital transformation. We have to make a whole lot of change in the organization. Right, so this means actually sometimes the organization may have to go away with what they have been doing in the past. Because when you introduce maybe a digital technology into certain business

processes, they have to be changed or sometime you may have to introduce some. Some of them completely new. So we look at the path for digital transformation, so digital transformation doesn't happen overnight. It is a long process which take. Complete we start with the digitization, so digitalization is basically focuses on your data and information. So if you take any organization naturally, they may start collecting data physically and recording them basically right. But of course that. Create so many problems when it comes to handling and management. So the first step in digital transformation where digitization happened, what you would do is you will compute rice. So change them into digital technology so that you can basically managed improper, share them properly and then of course secure them properly. The next step is digitalization. So which is? Basically focuses on processes. When you take any organization, they have different processes, you name it. For example in say, sales process marketing process. Purchasing process invented control process recruitment process, so all those may be happening right now manually.So then the second stage we are digitalization nap and what you would do is you computerized. Then you digitize them so that you can basically remove all the bottlenecks. Improve the efficiency and come up with streamline processes which deliver better. Services to your customers as we left. Your steak. The third level we called it digital transformation, which is our target. So in when you achieve digital transformation, it's the transformation of the entire organization, so not one single or two single processors. So not introducing basically certain systems to manage so. We have to. Completely transform your organization into an organization where everything is driven by digital technology. So then even your strategic focus. Will be completely different. When you compare with your manual tasks before digitalization. OK, so then when you talk about digital transformation, we focuses on 4 main areas, business processes, business models, culture and domain. So that is basically a business process. Business processes collection of past that you have. Within organization to do various different things. For example, we'll say if if a student register for a course, there are certain steps that need. We follow and if if. That the examination result seems to be released. There are certain steps to be of service. So then when you collect those steps you get the. Business process right? But in in digital transformation, what you do is you try to change those processes by introducing digital technology so that you will have a. Better efficient effective process which is going to be much, much better than. What it was before. Then the second area is business models. So basically business model is the process that you use to deliver would then services to your customer or in other words how you run the business. It's basically collection. We could say even collection of all the processes right? So the next step would be yes. You look at how you going to change the entire organization. How are you going to have the? Business delivery in a different way by introducing information. So then when you change your business processes and business model, so ultimately those are going to be used and operate by individuals or employees who. Are working

in. The organization, so therefore, unless you change the culture. The digital transformation will not happen smoothly because so then you have to get them change basically how they work, how they coordinate, how they cooperate, how they communicate, so everything how they manage and control things that need to be changed that. This year we talk about cultural transformation. And so at least so we need to have business process transformation. Business model transformation and cultural transformation happen within an organization to have a sustainable digital transformation. Sometimes when you introduce. I or integrate technology into or into the organizational processes. You may look at what is happening right now. You may do a short analysis to see what our strengths, weaknesses, opportunities and threats. So in such process you may sometime realize OK when we introduce. When we integrate. Digital technologies we may be able to go into other areas of business as well, so rather than just focusing on what we are doing right now so we can go into other areas. So that is where we. Talk about domain transformation. OK, so if you look at the industries most affected by digital transformation, you can see obviously the information technology I have about. So this is again I got it from absurd economies. So we recently published so 70% off. There is an impact or effect of 70% on information technology related industries then. So education is about, we'll say 3839%, and the government 20%. That doesn't mean, of course, there will be no impact. So basically these organizations have not. Adapted or integrated heavily technology into their

processes, so therefore there are lot of room for further improvement. And then of course, so this is again I got it from World Economic Forum, so everybody talks about digital transformation for business and industry. But according to them actually digital transformation create value not only for business and organization even for. Society has. So for example, if you take automotive industry, yes. So when they convert their business into digitalized form, so of course they will get value addition at the same time, there will be some value creation for the society as well. So of course we can see for consume industry, electricity and logistic. As well, so therefore so when organisations. Integrate technology into their business that will create value for the business as well as that will create value for the society. OK, so with that, we'll see what are the enablers of digital transformation. So there are several. So of course I have selected the main 7 because the time allocation is limited. So one thing is big data and business intelligence. So organisations are heavily using big data and business intelligence to make decisions to automate the things. So there are four big data. Is 1 technology enabled that? Facilitate digital transformation. The second one is in IoT Internet of Things, so now you see not only even industries, even household, they adapt or they introduce, they use various different type of IoT devices so that that make the digital. Transformation easier. Then the third technology that basically influence. So enable digital transformation is. Blockchain is a technology that basically facilitate. Transparent, immutable transactions where you need a lot of transparency to be maintained so you can see in everywhere

the blockchain technology is being. In another technology that enables digital transformation, is smashing, learning and artificial intelligence. So of course about 5-6 years back. Or maybe we would say 710 years back. So artificial intelligence was not the password, so they have a lot of limitations. But so things have improved, and so there are a lot of. Applications where you can use the artificial intelligent processes to do various different things, and organisations are heavily using machine learning and AI in there. Process automation. And when it's come to a digital transformation, mobility, ubiquity is something very important. So for that, of course, you need communication technologies, so 4G and 5G may place a major role in. Enabling digital transformation in that sense, and then the 6th enabler is cloud computing, so. Cloud computing is cheaper and the organisations need not to have specialist and they don't need to invest heavily on infrastructure so therefore that enables organization to basically ADAPT and integrate technology into their. Organization so cloud computing is another enabler that basically facilitate digital track. Then the last one. So sensory technology. So now you talk about autonomous cars, autonomous maybe with vacuum cleaners and then various different agricultural equipment which are being developed using sensory technologies and then various different. Business areas. Adapting the technology because of this sensory devices. So therefore sensory devices also can be considered and one as one of the enabler of digital transformation. But of course there are issues or challenges that need to be handled as well for smooth transformation, right? So inhibitors, so the major one is lack of vision and leadership. So you need to have a visionary leader in your organization to push. The digital transfer. If the leadership support is not there, that will never happen. There's a misalignment of it and business if any organization to sustain in transformation. Alignment of business and I tease requirement basically. So usually what happens is yeah, the objectives and strategic plans of the business as well as the objectives and the strategic plan of the IT department should be aligned. So they need to work together. If that doesn't happen, if they, if they don't talk to each other the digital. Transformation will never take place in an organization. Then another issue is little or no employee engagement. So the management themselves cannot implement digital transformation because so you need the support of everybody within the organization. You can't just introduce a system and force people to use it, so there you have to make sure that. OK, they feel they are also part of the process, so then only they will support the adoption and the integration of technology. So if there is no such process then it's not going to work. Then the 4th one. Failure to change culture. Right, so just as I told you earlier, just introducing technology is not enough. You have to make sure when you introduce the technology, the business culture, the working culture, the communication culture, basically how people behave and work within the organization needs to be changed. If that is not changed, the digital transformation will not. Then the fifth one metrics misalignment. So usually organization they have QQ key performance indicators, right? So then, while maintaining

the same KP that you have had for manual processes, if you try to introduce digital transformation. That will not happen because so your performance will not be recognized, it will be evaluated in a different way. So therefore it's very important that if you want to. Facilitated digital transformation. Make sure that you align your matrices with the. Current processes in another issue is information and security because so people are still concerned about, even though that's field is developing and there are a lot of technologies. But we know basically technology themselves will not solve the problem. So you have to have management control as well as process control. So until that. Happens so maybe adaption of new technology will not take place. The last one, so it's something very interesting not failing enough. If an organization is doing. So they don't need to change anything, why do they change it, right? Because we are doing well, so there is no pressure coming from the competitors, right? So we have been making the same profit that we made maybe 10-15 years ago. So why should we change that is the attitude. But of course, if they get the pressure from the compare teachers. When they start failing just then they will realize OK we need to do something to survive in the business market that is severe. They will think about digital transformation if they have not failed then that is also going to be an inhibitor for digital transformation. OK,

finally so I think I will go through quickly. So because I I think I have taken nearly 20 minutes now. Key digital transformation 10. So I'm not going to explain them off so that this this stuff because I have got it from Gartner focus on reliance and sustainability then. And emphasis on using cloud to enable innovation. AI fueled. Automation of business processes then continue acceptance of remote work. So basically we know that during the COVID period everybody was online and they start working from home, right? So that is going to be continued and then managing data for its entire life cycle starting from creation tools and then security as a business imperative. And then of course prioritizing AI ethics and governance. So when organizations start using AI heavily, of course. You have to have a better way of managing. And then finally the summary. The need to so we have discussed basically the digital transformation is universal. It's not just for industries, that's for the society as a whole last year. And of course, the IT vary from organization to organization and challenges that they face. And then, of course, digital transformation is beneficial for business and society. And finally, of course we need to understand that digital transformation is personal issue more than a technological issue.

Thank you!

Cyber Security: The Backbone of a Successful Digital Economy

Mr Ashoke Baddage

Country Manager, Check Point Software Technologies, Sri Lanka

I'm going to talk about cyber security. What I would call the backbone of a successful digital economy. . I want to discuss national growth and digitalization at very high level and then what are the challenges we may come across along our way and then why cyber security is becoming the backbone of a successful digital economy? And what is our role? And then if you don't embark on a successful digital transformation. What will be the threats that we may face and the cost of such threats other? Breaches that is happening. I'm not an economist, but so the theme today is about the digital transformation aligned with the national growth as well. So what is national growth? So, we measure the increase of GDP or national input output over the last year. And if you look at the economic development, it is not just the growth of income, so that will be measured by the quality of life. How have we increased our living standard over time? Have our educational standards been increased? The public services that we obtained day-to-day have been increased, or whether it is at the same level. And have we improved our infrastructure and then whether the economic activities have been diversified into different areas and across society? And the most important factor in measuring economic development is whether you have increased your annual income. So per capita income, whether the distribution is equal between the rich and the poor. So now when we are talking about the national growth and digital economy. It

is imperative that you know we must have a kind of technology introduced into. So basically, the economic growth is a subset I would say because of economic development of a country and it says we do not need to give much effort for growth because it happens naturally when there is economic development is happening. Everyone must develop an economy and contribute, especially if you look at it from the national level. The government should have the right policies in place with the right legal framework and provide the infrastructure needed. Development, especially when a digital economy. So, if you look at an economy today, so economy comprises of I would say. 5 pillars, right? So, you have your government on top and then your enterprises, businesses, manufacturers, entrepreneurs doing business on one side and on the left side, we have us the households. And we have the financial system in between to support this economy. And of course, we do trade between the countries, imports and exports. Business as well. So, what is growth? So, growth is when you and I increase our purchasing power when we have more money, we will buy more things, goods, and services. So, we buy from industry, the people who provide these things. So when we buy more so they also will get more income and then eventually what we do. We pay more taxes to the government. Right and the government responsibility is to provide us the required infrastructure

facilities for our growth. Now I extracted this from the ICT website. I'm not going to talk about it now, this is. The Sri Lanka government strategy. 4-4 years from 2020 to 2024, so they have given the architecture what they are going to do and responsibility and the stakeholders of everyone now. Here, what they are saying is they will provide the platform. They will provide the network between the government agencies, and they will provide the cloud. They will provide the cloud services also, and. Then interoperability platform along with the common database. So, this will be used by the different departments and ministries to give US service now.. For example, if I want to get my revenue license done so I go online and get it done. Right now I have two questions. Can I do it at any time? Is the system available and the 2nd is? Whether I'm exposing my data publicly, whether it is secure now? Those are the questions that we need. To ask. And,you can have a nice strategy. Implementing that depends on multiple factors. For you to do some homework, please look at this I CTS strategy and evaluate yourselves where we are today. Right? So when we talk about improving our productivity and digital transformation over the last two years, we have completely changed the way we live, work and learn. Because of the pandemic we were forced to do things that we never done. One of the key things is to increase work from home and then remote workforce. Now, many organizations were forced to let their employees work from home. Because they were locked downs and curfew, and people were unable to. Come to officers, officers to do their day-to-day work. Now, many organizations were not ready with the

right infrastructure to provide that facility to employees. Now what are the challenges that we face working from home? First, you need stable connectivity. You need to connect to your office, cloud, applications, databases, and such. No, exactly your employee can access what you're supposed to do, right? I'm not going to each of these things, but if you look at everything has transformed over the last two years, predominantly not only in developing countries, even world over, so things are changing. Me enterprises are moving on to cloud. Why Professor Janet also mentioned? Because that will help you to bring down your costs because rather than maintaining your own network infrastructure, your own data centers can provide these services from the cloud service providers that will help you to reduce your costs. And at the same time. Ensure that up time or the availability is 99.9% because I mean if you look at the public clouds, those are. Those are large organizations like Glue, Google, Microsoft AWS and things like that, but there is a fundamental question. When you move your data and assets to the cloud. Is it secure? If it is in your premises, you know with controls you can secure, but when you move things to the cloud, how do we ensure? That our data is safe there. So that is another question. Now if you look at each of these things, security is a serious concern, online education, is it safe? I mean if you look at today's education and healthcare. Is big business And later, I will show you the data breaches which industries have been impacted most.t. Right now, when you do a digital transformation process. It's not a one-step process but must be phased out. If you do not carefully plan it out, you will end

up in disaster. Right, so I would say technology provides a stable platform in order to. Go towards digital transformation and why we need digital transformation. End of the day. Just because everybody else is doing it. and consumers. Drive the digital transformation on the organization because consumers like us. We want things to be better. We want to get our things done faster, secure, right so? Companies will be driven by these demands and obviously they will be pushed to do digital transformation and the fundamental thing is the underlying technology which provides a stable platform. But having said that security ensures a safe digital life for consumers.

Now moving from the enterprise world to the I would say international level now few years back if you look at. Between the countries, what did they do? If they have some issues, they go to war, right? They had a physical war, but now this has completely changed now. Now you would see what is happening in Russia and Ukraine. Go due to that. How it impacted, so I'll tell you some. Stories about how this cyber warfare is happening between the countries is no longer physical. You do not need guns to fire collapsed buildings and bring down an economy, so cybercrime is enough to do that. When we are moving to a digital transformation, the government's job is to provide the. Utility basic utilities to its citizens in a much better way. So, they need to introduce technology in delivering utilities like electricity, water, gas, transportation, healthcare, education, these things. So, you need to have digital platforms and if it is not secure, what will happen? Somebody can you know, hack into these

networks, and bring down the entire thing and. The citizen will go completely, you know, blank. So, these things happened even recently when the gas lines were attacked, gas supply was blocked, and the countries during the winter have a huge, severe challenge. So let me tell you a story. Some time back Sony cooperation made a movie. Called the interview and basically the movie is about the North Korean president. And they portrayed a negative image of the president. So obviously North Korea didn't like it, so what did they do? They did not go into a physical war, they just brought down Sonic Operation Network and what is the impact to the economy of the US? So that impacted more than more than. I mean, I would say millions of Xbox users at that time, so this is the kind of warfare that is happening today and in Estonia. So they had a statue called Bronze Soldier, so this was before, you know, the. Separation when the Russian Federation was there. So once they separated, they what they did was they moved this statue from a very prominent place to very insignificant place near a symmetric so that Russia didn't like it because they value this statue a lot. So they what did they? They started attacking the government website. Estonian government website. They started attacking the media outlets and the entire banking system, so this is the warfare you see today. Also look at some of them. A major attack has happened recently, so we are talking about digital transformation. Now these companies that we are talking about have gone through these phases, right? So they have transformed, so they are providing better services through digitization to their customers. But still, they are. Attacked so we

will see why now the colonial. Pipeline attack that happened recently. Now the important thing here is that it was a ransom, so they attacked this company. And demanded ransom is millions of dollars so. The colonial pipeline decided to pay for it immediately, why? Because we did not have proper backup or recovery plan in place, there is no way that they will. They are going to continue their business operation, so they immediately paid. And I mentioned about the Russia attacking Ukraine and the other European countries. Many critical infrastructures. So like power, the gas supply, and things like that and then the Costa Rica County ransomware, again Russian attackers. So, they hacked into the country's financial system. Crippling the financial system. So why is this happening? Why is this happening now we said. Digital transformation is a carefully laid down process. Right, so you need to have your strategies in plan. Place the plans in place. And you are doing it investing millions of. Dollars or rupees and go to a digital transformation in order to provide. Efficient services to its stakeholders. The customers, right? And they have invested a lot of money. Then still. Things that I mentioned earlier is happening between countries cyber warfare. And criminals target the financial sector, the banks, and the enterprises. Still, it is happening. Is it because the securities solution providers companies like the company that I work for checkpoint? Which has more than 25 years of history specializing in security, right? Providing solutions. So there are many companies like that in the world. So are you trying to say that the bad guys are smarter than these companies? Why is it happening? It is not. So

it is an integration of technology, the processors, and the people. Now if you don't have a tight integration between these three. There will be issues not only marching towards the digital transformation even after doing that. How to the sustainability of the same project, right? So you need to have these things together, so let me explain why. So as a technology platform we need to have our infrastructure ready, whether networks, whether it's a physical network, wireless virtual, whatever it is, and then you have your computing power and your storage and other old technologies in place. So, that is the first thing you provide. Right platform towards the digitization, right? And then you have. Your applications, databases, APIs, and things like that running on that platform. Your platform is ready, your applications are ready, and you are ready to serve your customers. So, this must be supported in every country. With the right legal framework, because when you move to digitize the way we work, it is also changing, so we need to change some of the laws as well. Simple example e-mail communication. I mean if it is not legal. Because these days we know that when we even go to a bank to, we throw money, we need to place our manual signature. Has anybody here done that? Can you please raise your hand? If anybody has signed some document and taken money do not think because right now we are using digital forms, right? It could be an ATM machine, Internet banking transferring to somebody else, mobile banking, all those. Right now, the legal system should support this digitization as well, and this is one of the key areas. And then finally we need a proper

security solution. Is 1 solution enough? No, I do not think so. If you look at the companies that I mentioned or the government that I mentioned, they have invested billions of dollars into their security system still bridged.

Right?

One thing is what we can do is together so we can raise the bar that hackers are trying hard, right? So that is from the technology perspective. That is what we are doing. We are raising the bar to block these hackers. But still they become successful. Because you need to have the right processes in place. And you need to make your people aware in the organization and you should have the right digitally skilled people in the workforce, and integrate technologies and ensure proper security in place. Now today, if you look at security, it is not just a simple solution, right? So we might need a different solution to protect your networks, whether it is wireless, wired, virtual, whatever. It is, right? So you need different technologies, and you need to have other different technologies to protect. Cloud because I said when you move your data into the cloud you don't know you don't see if somebody else's hand. So you need to have different technologies to protect the cloud. And applications the same story and more important, the end users because the end of the day. Most of the targets are happening through the end users. End users in the sense of the. Employees, if you look at the university network, it's you right. You have important content on your servers so. If you don't act responsive. It's a huge challenge. Whatever the technology we have in place. Whatever the processors that you have in

your place and the people don't act responsibly, there will be a. Challenge so that is why the people factor is important and you have a huge role to play. Whatever you do, you even use your mobile phone. Right? The simple example is you know we. Are getting a. Lot of forwards, a lot of things that you know forward by different people with links and things like that. And emails so e-mail comes with attractive promotions. Click the link and provide you information. Those things right. So there are different ways of means. The attackers are trying. If we act responsibly, if you don't click the unknown and link if something that that is not sure best is done click. I mean whatever the technology. Sometimes I may not be able to help you. Now there are technologies. Having said that, if you look at the enterprise world, I mean there are technologies to protect the end device and users. The IoT and other huge, exposed area because I OT security is typical, we know when you talk about IoT it has become part of our day. Today life. I mean whatever device that we use, including the vehicles, the washing machine, the air conditioner, so all those things we can control remotely. And if those devices are not protected, again, those devices are controlled through the. Network end of the day, right? So the network is the platform for anything. So if you don't have the right security in place so you are in risk. And if you don't do that and throw these things away. To a basket, don't think about the right processes. Don't think about the right technology. Don't think about the training, your people and implementing a proper security strategy for the organization. This is the result, this research is recently done by IBM and they

say the largest compromises has happened through phishing attacks and. Business e-mail compromise. So end of the day both are the same, right? So these attacks have come through phishing and today most of the attacks I would say 80% of the attacks. Are coming through the fishing. So you need to have your right security in place. That's what I'm saying. One day when you go out and work for an organization. The number one fundamental thing is if it is an unknown e-mail, don't do anything because you don't need it. Right, I mean today there are multiple ways of communicating. So always you can cross check if there is anything important. Because the attacks that is happening today, it's exceedingly difficult for. Ordinary users to understand. So this is what I wanted to discuss with the time available. And end of the day. What is important is going towards growth nationally and individually and as an organization we need to embrace the digitization so when you do that, you need to have a. Very carefully laid plan. Things to consider when you have a digitization plan. Now I showed you the ICT plan strategy. The questions that I would ask you have a plan. Genuinely nice, nicely laid down plan. Do you have the resources to do that? Number one? Do you have? Do you have people? Do you have money to do that? If not, what is the point of having a fantastic document, right? Do we? Have people so. These are the questions that we need to answer and review the digitization plans like six months or one year time and see where we are. If something has gone wrong, then we need to identify what the things are. Whether we did not have money or something else. We didn't have. People understand those things and address those things. So what I'm saying is. It must be more practical. We can lay down processes. I have been tried and tested by large organizations but having said that end of the day things needs to be practical so those things you need to. Properly identify and work accordingly, and if you do that, you have a successful. Digitization program in any enterprise. And at the end of the day again, I would say you can have a kind of a nice platform to drive your digitization efforts, but. Cybersecurity is the backbone of a successful digital economy. Because if you don't have the right security in place, it can collapse at any moment. With a single attack single malware.

Thank you!

Artificial Intelligence (AI) and Natural Language Processing (NLP) for Digital Transformation in Healthcare

Prof Damminda Alahakoon

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My topic today is Artificial Intelligence and Natural Language Processing for digital transformation in healthcare. Now Healthcare is a very important area for obvious reasons and technology and digital transformation has impacted and continued to impact heavily in this area. I will talk about digital transformation in healthcare, but I plan to go dig deeper into one particular area, of how we are using artificial intelligence and natural language processing to generate value and for better patient care. To give a high-level introduction in healthcare so the digital transformation in involves the option of technologies with and, what is the objective? The goal of this is to improve the workflows in healthcare efficiency and of course patient care. And this is some information. So, I extracted from this website there can be different technologies that are brought into the part of digital transformation in healthcare Internet of Things, obviously, and the big data which is not only the volume of data itself, but there's the variety of data, the variability of the data, and so on and so forth. Telehealth is making huge impacts. It's really important. Virtual reality is being used more and more in healthcare and of course artificial intelligence, which is what I'm going to focus on. And so why do we do that? What are the benefits? I'm not going to read this out, but the highlight is patient satisfaction and engagement which is very important factor. And some more information about artificial intelligence and that makes personalized treatment possible because one of the key objectives of artificial intelligence is. To be able to provide personalized, it could be services. It could be products. And in health care personalized treatment because With the huge population that we have and it and the different needs of individuals and changing a needs it's impossible to keep track of all different variations so that. When you give services or develop products without just with manual or traditional resources. Artificial intelligence is heavily used and relied upon, and there are some figures here that 84% of industrial testing say will transform. It is definitely already transforming and it's huge dollar value. So AI power tools that expected to exceed 34 billion in 2025 and many startups and so forth. And you can get similar information from various sources, including consultancy firms research. And various industries, but I'd like to give before I go into the details of some particular AI algorithms, innovations that we are

working on in at the Center for Research Center for data analytics and Cognition at La Trobe University. I'd like to give you some context about the type of AI that is required or that is expected in the information age, so this picture on the left shows very much historical before the 1950s and so on. AI or the type of machines that work or think like humans have been around or people have been thinking and talking about their various stories and even building machines that are type of human. Like but it was in the 1950s 56s, it was actually in 1956 that the term artificial intelligence was coined and with the advent of technology and computing. AI has changed from the actual components that were built into computer programs and then of course with the so-called machine learning algorithms and with the availability of digital data in massive volumes. The expectation of what artificial intelligence would give us or can give us has evolved and changed over time, but in the current world, which is called the information age, or we call it's a digital world, there's so much more information and. Of course, we do many things and I guess we don't even know the type of information that about ourselves that we leave on various. It could be social media, it could be just various interactions, which are various technology platforms that we use. Our communications, even our movements. Because these are digital information, which is captured by artificial intelligence. The requirements and expectations have changed from algorithms and tools. Tools that are specifically built for a particular application. There are technologies which are more humanlike, or

which coexist in this information world and they can interact with the environment without direct supervision from humans. And I don't know that this is not the time to go into details of artificial intelligence, but there is a trend towards what we call the artificial general intelligence where human being is not there to supervise. And even for first of all to build. Then to adapt, adjust, monitor and then of course look at the outcomes from the artificial AI and to evaluate analyze that. So AI in the current requirements and going into the future. Is a different type of artificial being, which can coexist in the information age. Now coming into the type of work that we have, we are currently working in artificial intelligence or artificial intelligence innovations. We work on computer vision, Internet of Things including wearables, speech, analysis, facial expression, recognition and so on, and AI for managing large volumes of data. And data fusion multimodality in data. Now that's something that we have to highlight, the importance of multimodality and the ability to handle multiple modalities is really significant. Now, one of the reasons is that compared to a few years ago, there is now so many different models when you say modalities. It could be audio and video of the same situation. That are corrected and the patterns or interpretation of this with artificial intelligence will require, or the outcomes will be better. If the AI can make, use or bring these together so we call this data fusion. If the audio, the speech aspects, and the video. The vision aspects can be brought together and then that can be further validated with textual information and some other information, and such

algorithms are being built and already becoming being used. Then streams of data. It could be from videos in code from IOT, and so on, and so forth. But there's all this work happening, but today I'm going to specifically talk about some very interesting work that is currently happening about emotion capture and modeling with text, social media videos, and so on in our research lab. Why do I go into this particular area? Because I thought we not only have developed some real innovations in this, but we are also currently putting it into actual use with the Australian as well as international collaborators. And it gives a sense of the value. The benefit that this type of AI and natural language processing can bring us. So there are several very interesting projects where we are using artificial intelligence, health, technology and definitely fit into the digital transformation in healthcare. I've listed out three projects here. The first one is called artificial Intelligence based Co facilitator. So, in collaboration with the particular Healthcare Institute called Resource Institute and University of Healthcare in Canada. Communication with online patients using artificial intelligence technologies and two other projects. NHMRC stand for National Health and Medical Research Council funded. Projects from in Australia. These are Australian government funded. Projects where we are building artificial intelligence based or empowered technologies into stroke recovery of patients. So this is the first one is about personal line stroke recovery and rehabilitation through new technology for people living at home. Now the living at home part is really important because this is something really valuable that technologies and artificial intelligence can benefit that can provide society instead of having to live in hospital setting. Things or having to frequently go into and attend clinical settings. The people can stay safe and healthy, and the in their own comfortable home environments using the new technologies as well as well as monitor. Or by using artificial intelligence, the communication connect the final project that the third project that I have listed here is really interesting. Some of you might be aware of the term aphasia. This is after stroke. Certain people, depending on the particular part of the brain that is affected, have communication difficulties, and it's really major problem because it can be quite young people as well and so they have the their thoughts, ideas. And so on. That's arises, but they are not able to. Right and we are working. We are working with official experts, neuroscientists in Australia and around the world in bringing in artificial intelligence, including vision, speech analysis and emotion analysis to address these. A very high level picture of one of the projects. This is they're staying connected, so and again it's important to understand that to position these particular projects and particular innovations and artificial intelligence. That I'm presenting to the overall picture of digital transformation. So these these are new technologies, new frontiers in healthcare that are being empowered by artificial intelligence techniques. So in this case we capture different sources than the types of information from mainly 3 different sources, but that we are going to include

further. So this is the current project which has currently working on and to be trialed in the next couple of months with the actual patients. So we have collected data from wearables particularly accelerometers where the patients who are in their post stroke recovery. They are wearing and then we have developed an application which is personalized. What we call experience sampling where several times a day they are prompted with the questionnaire so that we understand from their moods what they're doing, where they are, what they ate, and so on and so forth and there's actual videos where we have something it could be zoom session. Or in other cases we capture videos which capture their trials and then they are asked to do certain activities and their movement and so on and also in addition facial expressions gestures are captured. All that is brought together and there's we have developed some. The new algorithms and of course that's the you use interfaces that are developed as well. So, the wearable sensors from physical activity monitoring, personality modeling, which visualizations and so on and actual conversation from the experience sampling app and you may just and videos. We all brought together, and we are developing a central information hub. These are multimodal information fused and run through artificial intelligence-based analytics. Components in this they are the actual mobile applications which are developed which will be used by the patients. And there are cars in the home settings. And then there's a central hub where which will have which will collect all the information sources and communicate back and forth with those patients. And finally, on the right hand side, there's the artificial intelligence, advanced analytics modules, natural language processing, and so on. So what happens is that there are four different types of apps that they'll be chat bot, social application, app therapy app. Actual therapy is provided through the mobile labs to the patients and then particular situational information and so on. What if they are walking around, they want to have somewhere with their communication that will help and assist with their communication difficulties, but the most important factor, where is artificial intelligence? The most important contribution from the actual in the applications the apps will learn the individual peculiarities of the person during use. So if once they use it for a few weeks. Each individual is different and that individuality will be captured and it will adapt and it will learn that this person cannot say these particular. Types of words and or express these kind of speech deficiencies, emotional they and they are particularly they get upset or they don't. They dislike certain types of words and so on, and the AI will help. To adapt the. It could be the chat bot, the social apps and even help in providing the more customized and tailored therapy with. This information is transferred and and this is done via individual patient. Our tasks that are developed in so this is again currently. The initial phases are done and it will start trialing this with actual patients in the near future. Visa, several of the key applications, but what I would like to present is some very interesting modules on the emotion capture side and I will skip it then say why, why emotions are so important? Because in

more in many cases what we do, what we say and who we are. Is depends on our the the OR can be represented by the emotions that we express and because of the availability of different digital sources which capture our emotional footprints, it's possible now. To build representations of these, and of course can put to good value. So for example, one of the projects that we carried out is using online. You know the forums, so there are online cancer Cancer Support groups where patients. Express various thoughts, opinions and the issues that we face and so on. And we have used natural language processing to identify the this information from hundreds and thousands of such conversations. And this information can be particulars such as age and so on. If when they are expressed or particular clinical aspects. In this case, these Gleason values and PSA's and so on, and also decisions why a particular type of surgery was and then and then of course, but interesting the last. It's the type of emotions with the current mental condition of this patient. Now this was really, you know, because we in particular cases, working with cancer clinicians, we found that the. Amount of information. And the the the the the, the, that that is expressed in forums is much more and that compared to a questionnaire or interview that the patient because it could be because they are typing this in or in this information into the forum from their own settings from home. From their bedroom and feels much more comfortable. And this was really significant with prostate cancer patients because these are men and it it's on that men don't generally like to talk about all kinds of medical issues and healthcare issues. Even

with the clinicians, while going to the forums, the clinical supplies that the amount of information, the detail. Including after effects of various drugs and the the the medications that they have. The basically expressed in the forums, but it's humanly not possible. It's not possible for a human or a clinician for anybody to go through, read through each of these. That's where artificial intelligence natural language processing has really been useful. I think in the next couple of few minutes I will just point out some interesting modules or AI innovations. That we particularly have built in into capture emotions. Now what we have done is used a psychological model called the prusiks wheel and use. This is the push six wheel. It's a psychological model of our different emotions. So if you look at so, there are eight key emotions. For example, there's joy, trust. Fear and so on. But for each emotion there is an intensity value, so there's the. For example, if it's very high it's ecstasy and serenity is the more lower level of the. Joy and ecstasy is very high intensity, similarly from so. It could be fear. Could be apprehension if it's lighter. When terror, if it's much higher. Now we have built components you with the say from the, from the conversations that they have. To capture these. And then represent this as now what we show here is for each individual, for based on their conversations we can actually capture this person. So there are these two people. One, you can see that one person is more towards terror and rage and so on. While this person is more towards more. And this is somebody with something like a bipolar, somebody who's moving from ecstasy to go. And another really important thing that we have

done. I know that I'm going to detail, which is very different, but just giving you a highlight so you're not supposed to read all these. Texts and so on but. By capturing the actual emotions that are expressed with these. The psychological models or computational versions of psychological models over time. Because there are patients who express these or participate in these forums for several years in fact, and we can actually use something like a state transition diagram, how their emotions change over time. And so this is the different types of emotion, and this is one person over her particular conversation, and this is 30 minutes. 60 minutes and 90 minutes. How the emotions have changed and so on. So you can identify their profile. A person of who this person is, how they change. Question is. And another thing that we have done is that we we can actually represent using emotion sequence like DNA. Sequences represent our biological nature and we are asking the question can we represent the person with their emotion sequences? I will just quickly move on to so where, where, where? Where do we put this? Where does all this information and from a healthcare technology perspective? What value does it bring into overall healthcare? So our research helps to build assistive tools for clinicians. That can manage here because as you know, mental health is a huge issue and then identifications of psychological issue. And clinical interventions, awareness and one of the the biggest areas of that. Not only us, but that's really bringing in value, is mental health chat bots because chat bots are currently being is becoming very popular. And finally, I will present this is actual. Currently the the We have deployed this technologies in this online cancer care program in Canada. The the type of the emotion capturing and representation technologies and artificial intelligence that we have developed has been actually deployed in this cancer cancer chat delta that that's online cancer care program and it's already it can do real time emotion analysis and identify not only individuals. But in Group conversations, how certain people are feeling, their emotion fluctuations and so on, that enables providing more targeted and tailored care and help the conversations from the clinicians.

Thank you!

Why do so few digital health innovations disrupt practice? An iterative technological, business and clinical use-case model

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The topic that I'd like to talk about is digital health innovations and how are they, so few of them actually have resulted in disruption, and there's the point that I I'd like to make the points by reflecting on some of the experiences that I've had with artificial intelligence applications in. And then in health. First, let me make the general point that I don't think I need to tell too many people here.That information and communication technologies have disrupted. Just about every aspect of life. If you consider that the World Wide Web may have been a emerging technology in the early 90s and has disrupted as much as it has. But right now we have a number of emerging technologies, including artificial intelligence. And Internet of Things and. The, the 5G6G and many others. Each of them have the potential to disrupt phenomenally. We certainly live in interesting times. As an example, back in in the early 2000s. My PhD research then was in applying machine learning and integrating it with argumentation theories in order to develop models that could do. Things in law. So one of them was the stood up system where we predicted the split of assets that have family court judge would award. Our husband and wife following divorce. Another one was to do

with eligibility for legal aid, which was decisions about the merits of the case and the likelihood of winning a case were made in order to determine legal aid funding, and we model that and built a electronic logging. System so that lawyers could apply online have a intelligence system. Make a merit based decisions and. Immediately, rather than wait for in those days 2, two or three weeks for paralegals to do the same thing. If you do law, nursing law, sentencing law. That led to a spin out company that now no longer exists, could just exist and we developed a commercial versions of many of these systems and other systems as well, including ones for state government departments and. Education departments and other. Are the bodies. For a number of commercial reasons that the that start up wound up in the mid 2000s, cash flow and other problems not unfamiliar to. Start-ups. And at that point I thought, look, you know I want a new life and returned to full-time research and to I wanted to change of scenery and I thought let's move into health. Let's apply some of this sort of AI in to health. Where there was a great. Potential benefit. As professor. Other cool has just outlined some 4. AI to be applied to health for great benefit and some of the technologies like the Internet of Things,

telemedicine, wearables, AI modelling, image processing. This been very active. Research areas for quite a quite a while. However, very few of the applications actually end up in clinical practice, so that led us to say, well, why not? OK now? Our conclusion is that in order for a. Innovation to. So you. The progression from a good idea in a research environment. Practice we need a convergence of three. Quite different things. And the convergence is quite rare. The three things is the technology's got to be good. The AI has to be smart. The hardware's got to be robust, reliable, accurate. But that's not enough. There's got to be a strong business case. It's got to be cost effective. It's got to be affordable. The customer who is going to purchase it. It's got to be the person. Who benefits from it? If there's a mismatch? There we're in trouble. That's not enough. It's also going to be a a strong clinical case. In that. It's actually going to be clinically useful for practitioners for nurses for patients. In the healthcare system. Now I want to demonstrate with a few examples how this convergence is actually quite difficult to achieve and that it is and then suggest things that can be done to. Realize this convergence a bit more easily. So first of all. Let's say, well, why is this convergence difficult? Well, let's start with technological innovation. Well, typically, typically that's done in universally research innovation. Well, quality is measured by publications and grant income, so there is no incentive or very little incentive for in university researchers to take into account the business or clinical case behind the programs are run and on I'll. I'll go through

a few. In a minute. The business case really only kicks in now when entrepreneurs hunt around for research outcomes that might. Attract investment and. You know, being the right for startup. And the clinical case is typically only examined in a in, sometimes in in the university, research projects run pilots, but typically a the clinical sort of case is really only explored when. Minimal viable prototypes that developed in order to test business models and that's after well after the original research has been done. So there is this separation of activity between those 3. So let me let me use this as an example. This is a piece of work that a piece of research that has done in in Victoria funded by the state government that are LED in. 2012 to 2015 and what we were interested in is whether we could come up with the technology that would transmit 3D. That that's yeah, left and right images. And then into leave it over the Internet. With low enough. Bandwidth so that we could run video conferencing in 3D. So that the. The practitioner, the health practitioner at the at one end with 3D glasses and a. 3D smart TV. Could see the patient who was transmitting images from a 3D camera. At the other. End and we had different applications of this. One was for wound management, where nurses would go into patients home and take a 3D image of a wound. They were still images. In a store and fork system, another application was in psychiatry, where it was a video stream, another was in dentistry. With tele dentistry and nursing homes. And but the psychiatry use case looked pretty good because. The stochiometric there at our partners at the University of Melbourne

would often travel into the country to do cognitive. That that they could do things like finger to nose tests and things like that we were surmising if they had 3D sense of think a wound specialist thing can view a wound. In 3D, and make a better assessment. So we spent a fair bit of time getting the technology to work in low enough bandwidth for the Internet links that we had. And we used the. Cisco hardware to do a first iteration. Then we use the web RTC library, then to build in 3D in software. Where was the? Business case well, we thought, well, you know psychiatrists wouldn't have to travel as much. To the country areas and that saves them money and time that translates directly into money and the clinical case. We thought, well, you know they can make these assessments where. You really do. Need a sense of time and space. And it made. Hence, scheduling was a huge challenge because you had to get the patient at the at the same time at one end, but you needed the healthcare professional to be with the patient. The psychiatrist is was at the other end and the technology had to work at the same time and. It was a challenge, yeah? When we looked at the business case. The saving time of the psychiatrist was actually not a very strong incentive because they needed to go to the country for. Other reasons anyway. So it didn't take much to blow the business cards out. Of the water. Didn't take much to blow the technology case out. Of the water. But we did overcome most of the technological. Problems and we did run the system. So when you. Stand back and say well what went wrong. Is what we. Really would have been better to do is to.

A little bit of the technology examined the business case without fully developing the technology and seeing if there that that there was a business case for the technology as initially developed. And if so, proceed and see if there's a clinical case and then keep on iterating slightly changing the technology to see if there is a business case that will emerge and slightly changing the business case means you probably have to change the clinical case and you just keep on iterating. You know, until you have something that looks like it might work. So we put that idea to practice in 20. 2012 25th 202015 we started in in with IO2 sensors to transfer. Biophysiological data to cloud service to process the data. In real time. Lots of applications. My colleague Venky wallet Subramanian had just finished his UTS PhD at in 2008 with monitoring heart rate during pregnancy of mothers and we got some philanthropic funds. To develop a word metric technology that would stream the data. But we stopped there. What we did. Is start looking for a really good use case that might have a business case and what we found was that the use case is. In remote monitoring of vital signs outside of intensive care and there's many settings, particularly in India where patients in in transferred out of intensive care. Into general wards, but still benefit from having continuous monitoring of their vital signs. And there's been a number of studies that have demonstrated continuous monitoring and vital signs and genital warts leads to earlier detection of patient deterioration and better treatments. So this is a few photos from back then we ran. A an initial trial in 2016. And that led to a

redesign of the technology which led to a tweaking of the business case which led to the spin out company, Allegra and A which was launched in 2016. And the next three or four years was spent doing clinical trials, mostly with hospitals in India and. And the. To fine tune that business case and the clinical case, and. And so when we when we look at the technological case here, well, the hardware is pretty robust, it's CE. And now TGA certified the smart alarms were came from. Sort of some research ideas that we had with machine learning. Tailored for early warnings. For the business case for hospitals we've sold to the Indian Defense Force to hospitals and. And The Who benefit because of this early detection. And now we're moving into patients at home with different use cases. And we've got to tweak the technology a little bit more, and the and the clinical cases. Essentially the early detection. Is that leads to better outcomes and it's worthwhile for hospitals and patients to pay the relatively small amount of money for the continuous monitoring in the general reward, particularly if they can no longer afford to stay in intensive. Court care at a quite high costs.

So what we say, well, you know in.

The in the startup space there is a simplified business model called the Business Canvas that is used to help miners define a business model. What we argue. Is that a similar structure? Simple can be useful that describes the technology, case and the and the elements of the technology canvas are different. It's things like to do with the technology. It's not. It's how complex is the technology. How safe is it? What's the usability? All of those things that are relevant for making the technology case and similarly the clinical model Canvas. As a way, and again, a very simple way, and it's really just like the business canvas. It's a simple template that you can use to brainstorm and different configurations of clinical workflows, and you know does it for them. This workflow is what is the value proposition for the end user. What training is required? What are the environmental factors? Things like that and what we believe is that this relatively simple model technical business clinical case can be used to encourage this kind of convergence.

Thank you!

TECHNICAL SESSION

Challenging Issues of the Railway Ticketing System of Sri Lanka

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Abstract: *This system is formulated to overcome the significant flaws in the present scenario and the consequences of traveller ticket buying and seat reservations, which frequently lead to mistakes and a lot of issues. In Sri Lanka, thissues. Therefore, people are focusing on using their private vehicles for at reservation prencouraging people to public transport is a better way to solve the above-mentioned troubles. But public transport should develop in a proper way to make the journey comfortable for each passenger. This is one of the purposes of this research. The existing ticketing and seat reservation system of the Sri Lankan railway, it happens on a manual method. Therefore, passengers faced lot of issues such as waiting in long queues, no proper way to make a seat reservation by self, passengers should wait a long time to make a reservation and so other issues. This research identifies those issues by using two methods. Firstly, use observations to detect issues by visiting some train stations. The second method is an online survey. After detecting the issues, research moves to the analysis part for identifying the system features for reducing passengers' issues. The main purpose is identifying the system features and functions for Smart ticketing and Seat Reservation systems for Sri Lankan Railway. People can prevent their issues by using this application because system features can reduce the passengers' issues.s identifying the system features and functions for Smart ticketing and Seat Reservation systems for Sri Lankan Railway. People can prevent their issues by using this application because system features can reduce the passengers' issues.s identifying the system features and functions for Smart ticketing and Seat Reservation systems for Sri Lankan Railway. People can prevent their issues by using this application because system features can reduce the passengers' issues.is identifying the system features and functions for Smart ticketing and Seat Reservation systems for Sri Lankan Railway. People can prevent their issues by using this application because system features can reduce the passengers' issues.r making a comfortable journey for each passenger. This is one of the purposes of this research. The existing ticketing and seat reservation system of the Sri Lankan railway, it happens on a manual method. Therefore, passengers faced lot of issues such as waiting in long queues, no proper way to make a seat reservation by self, passengers should wait a long time me to make a*

reservation and so other issues. This research identifies those issues by using two methods. Firstly, use observations to detect issues by visiting some train stations. The second method is an online survey. After detecting the issues, research moves to the analysis part to identify the system features for reducing passengers' issues. The main purpose is identifying the system features and functions for Smart ticketing and Seat Reservation systems for Sri Lankan Railway. People can prevent their issues by using this application because system features can reduce the passengers' issues.es.

Keywords: *Smart Reservation, E-ticketing, Train Ticketing, E-transportation*

1. Introduction

One of the most significant modes of transportation, the railway is essential to the transportation sector. Getting train tickets has been a major issue with such a large client base. At the busiest train station, there are lengthy lines in front of the ticket booths everyday. Time is wasted, and the majority of domestic and international passengers have encountered several issues with the current railway seat reservation system. Before making a reservation, there is no correct way to consult the train schedule. Through electronic trade, the issue of train tickets may be resolved. Implementing a new online ticketing system is not only technological advancement, but it will also improve railway services and, to a certain extent, resolve the challenging problem of railway ticketing.

System features should be identified before the online ticketing system is put into place. Due to system features, the current train seat reservation system's problems can be resolved more effectively. The preferable approach is to first identify the present challenges and issues with the current ticketing system before identifying the system's features. Since it is crucial to implement the system's features. Therefore, two strategies were mostly used to identify difficulties. These two techniques are the main subjects of this study. Observations come first on the list. Train stations are visited in order to get the observations. Because observing issues in some study fields is a terrific and effective strategy. As a result, the suggested research

uses observations mostly for the process of problem identification. However, once in a while, a hundred observations don't result in useful information for related research. Because observations are seldom a perfect representation of the event at hand. Therefore, it is not sufficient to identify issues solely through observations. A questionnaire is used in this study to highlight problems with the current ticketing and seat reservation system. It precisely captures problems, and through research and a web-based system, solutions are made.

This research paper proposed a web-based system with solutions as system functions or reduce all issues regarding with current ticketing and reservation process in Sri Lankan Railway. In the present technical world, different type of manual processes is converted into web-based solutions. But it is a huge issue not using an online solution for ticketing and seat reservation. Therefore, a lot of practical issues happened, and those issues encourage passengers to an online solution. Passengers prefer to use a web application or mobile application for the mentioned process. The proposed system has different types of features to make it comfortable for the passenger for their transport purpose. All features are mainly dependent on issues that are grabbed from passengers. The main purpose of this research is to identify correct features for ticketing and seat reservation system according to passenger's requirements and issues. Therefore, proposed applications have different types of features and functions. Some of them are, passenger able to make a ticket on their own, passengers able to see seat format and other facilities by the application before a reservation, online payment facilities, and other features. In the analysis phase, all features have been discussed in detail. After identifying correct features and functions, it makes proper way to develop a better solution as a web-based application for Sri Lankan Railway passengers to feel easy during their transportations

2. Literature Review

According to this research paper, the Researchers discuss guideline applicability and propose a method for evaluating rule effectiveness in rough sets. Moreover, provide a way for obtaining the most effective rules. In comparison to the approach for obtaining the fascinating rules, this one is straightforward and objective. The rule of interactive Ness must take into account prior knowledge of what types of information are fascinating. This technique significantly decreases the number of rules created while providing a measure of rule effectiveness.

Moreover, the researchers build and implement an online train ticketing system in this study: the data access layer, business logic layer, and business exterior layer composed up the whole system. Customer registration, cancellation, ticket inquiries, online booking, and online ticket refund are all implemented in the system. The focus of this system is a business process and database design,

which are clearly and effectively developed through business process diagrams and database ER diagrams. Travelers will receive real-time ticket messages via the online railway ticketing system. The reservation efficiency has increased, manual booking flaws have decreased, and the administration of railway passenger transport and customer reservations has improved.

According to the research, online train reservation is one of the best innovations in the rail industry, and those service providers that have not yet accepted online reservation systems should forfeit. They may see extra expenses, maintenance expenses, and production costs as pitfalls. However, business is more than almost any other invasion, and it is a constant negotiating with the coming years and persistent assessment, an instinctual forecasting activity. The World Wide Web and the Internet have emerged, and transportation firms will take advantage of this chance to build online reservation systems and flourish in the future.

This concept envisions a significant shift in railway operations and passenger experience. TTEs are provided with hand-held devices to make passenger confirmation easier and faster. The tickets include a QR code on them, which is read by HHT devices. A passenger-specific URL is saved in a QR code; when the HHT device encodes this URL as part of the Scan procedure, it directs to the PRS server and retrieves the encoded data to verify the traveler. The scan procedure refreshes the details of all passengers on board and informs the DSA server if a seat is reserved or empty. The check-out method allows travelers to stop their travel at any station and get their remaining money while having their vacant seat filled by a waitlisted traveler. The reservation portal allows users to book tickets for travelers. These technological improvements to the train increase transparency and minimize tout behavior during the high season.

Smart trains have been introduced in developed countries leveraging the internet of things (IoT), which allows them to take advantage of the opportunities offered by the Industrial Internet of Things (IIOT). The survey in this article focuses on various communication methods within the IoT paradigm like Global System Mobile Communications- Railway, Long Term Evaluation, 5G, and Wireless Sensor Networks. The passenger ticket production and validation were detailed with the Unique Identification Authority of India database as part of the smart rail transportation vision of India 2022, and the testing results showed that the IoT system is more practical than the well-known approach. The results revealed that passengers could get tickets in fractions of a second, that the reservation chart included the travelers' names and photos, and that adequate customer reservations were preserved.

According to this research paper, anyone with a login can access the data. So, in addition to ticket buying, this application will also include ticket cancellation, ticket and train status, and live station info. The primary focus of this research is to provide a user-friendly interface for all clients that will assist them in whatever way they require in response to their questions. This program must be beneficial to all of the travelers that use trains and must fulfill their expectations.

3. Research Methodology

In Sri Lanka, the railway network has spread via the main cities. But currently still use a fully manual system for ticketing and use semi-online technology for train seat reservations. It makes a lot of difficulties for passengers and railway officers. The ticket is issued by a manual method. It is a very primary level. It is an obstacle for the tourism industry. Train seat reservations are happening with some online systems. But passengers should visit a train station to reserve a seat. Otherwise, passengers can reserve a seat by a mobile service, but it has additional charges than the ticket value. There are a few entire issues with this traditional ticketing system. There are more problems and issues were identified by three types of methods.

First method is observations by visiting some busiest railway stations in Sri Lanka. They are Colombo fort, Maradana, Gampaha, Galle and Polgahawela. At those railway stations, the most common problems were visible. Daily at peak time, passengers faced a lot of difficulties. The reservation system was done manually before the advent of modern technologies. This meant that someone planning a trip would have to waste much time standing in lines to buy their tickets. The manual reservation procedure was also subject to human mistakes, resulting in an outstanding level of frustration among tourists and local travelers. Long queues at ticket booths are caused partly because most stations do not have enough ticket counters to satisfy peak-hour demand. However, increasing the number of ticket counters to service during peak hours is not realistic. Another factor is the amount of time it takes for a single passenger to purchase a ticket. The person behind the counter is responsible for issuing the ticket, and this transaction will take longer to complete due to this. Tickets printing cost is also high. Furthermore, it is not easy to catch any imposters who travel without using tickets.

Identifying problems by observation is limited. There may be more problems that can be discovered from passengers. Therefore, getting more from the passenger is a convenient method for grabbing more issues with ticketing and seat reservation. An online questionnaire was made better analysis by getting responses from passengers.

The questionnaire was shared through real railway passengers in Sri Lanka. They have given answers to question about my experience with train ticketing and reservation. As well as they have suggested more difficulties that they have faced. It is very important, because there may be a different kinds of issues that cannot be identified by observations. The questionnaire got about fifty responses

The first question of the survey considers about residence areas of passengers. There seem to be passengers in different areas of Sri Lanka according to the result. Most of them are near to Colombo. But some are remote areas to Colombo such as Trincomalee, Madawachchiya, Bandarawela, Nuwara Eliya, Eheliyagoda, Kandy and so other areas.
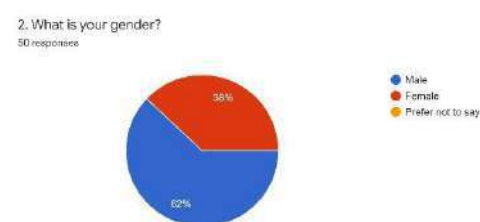

Fig. 1. Residential areas of passengers

According to survey respondents, the train is most used by men and most passengers are in 21-30 and 31-40 age groups.
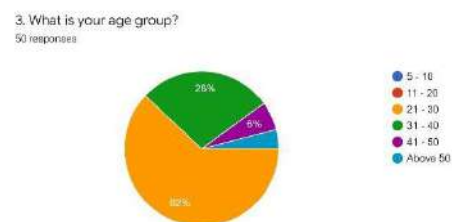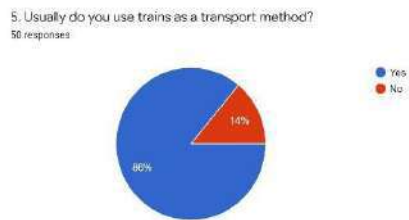

Fig. 2. Age groups of passengers

Fig. 5. How to use the trains

What this figure show is very important to this research. Because this shows how passengers have used the trains. It means around 86 percent of responses of passengers usually use trains as their transport method. As well as around 58 percent from responses of passengers use trains daily or more than two times a week. Therefore, those resource persons of this survey are more related to current ticketing and reservation method.

Fig. 6. Percentage of passengers have been faced issues

This is a critical key point of this research. Because one of the main purposes is identifying the issues that are currently available. This pie chart shows 88 percent from responses of passengers have faced a different kind of difficulties. It represents the need for this research properly.

This research paper mainly discusses issues in two processes according to as mentioned earlier. The survey first focuses to identify the current issues regarding ticketing. Some issues could be identified by observation, but it is insufficient to move a conclusion. When considering the survey responses, different kinds of issues can be identified.
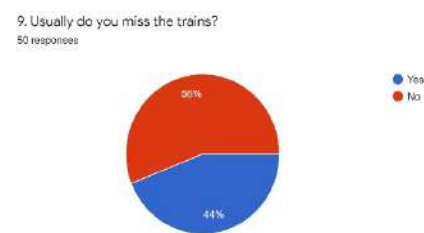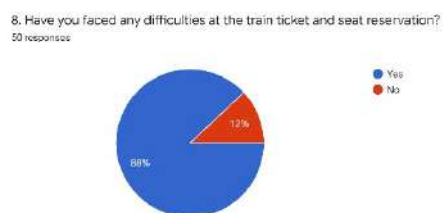

Fig. 7. Percentage of passengers who misses trains

This is an important question for identifying issues. There 44 percent from responses of passengers usually miss their train. As well as they have provided reasons for train missing. Such as taking a few times for ticketing, a lot of traffic on main roads, unable to buy a ticket because of long queue in front of the ticket counter, delay in purchasing ticket, no proper details to visible about train details, long queue and such more reasons. There for according to responses, lot of passengers face this issue.

Fig. 8. Time ranges of passenger reaching train stations

This question is used to identify the time range that passenger visit railway station before the train leaves. It is important for point out the necessity of web application. Most people arrive train station 5-15 minutes before the train leaves. As well as 20 percent of responses from passengers arrive train station less than five minutes before train leaves. Passengers provide solution for mentioned incident such as road traffic, dependent on off tie of workplace and save time. If they should wait long queue for ticketing more than five minutes, the train is missed. It is an issue.
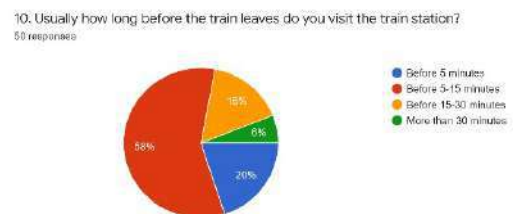
Fig. 9. Time ranges of passengers who faces the issue of missing the train before arriving to the train station
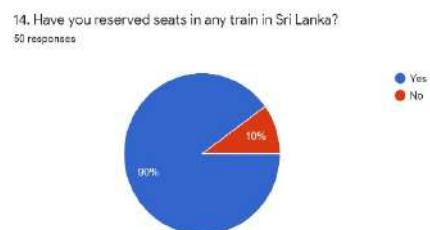
Fig. 10 Percentage of passengers who have reserved tickets from a system

The responses are collected to this question from experience of passengers. 90 percent of responses of passengers have reserved seats but they said they should wait more than 10 minutes for ticketing. 44 percent wait 5 to 10 minutes for ticketing. It is a big issue because it wastes time of people. As mentioned before, long queues are main reason for this situation too.

The question is about the ticket of currently use in Sri Lanka Railway. Most people mention that details printed on ticket are insufficient. Only Start point, end point, ticket value and train class printed on ticket. It is an issue too. People who not aware with train transportation unable to get proper idea about own route. Specially for foreign passengers.

List of issues regarding with ticketing according to mentioned

> Long queue.
> People delay reaching train station because of road traffic.
>
> People delay reaching train station because of off time of workplace.
>
> Waiting lot of time for purchasing tickets.
>
> Insufficient train route data on ticket.

Secondly focus about the issues regarding with train seat reservation. Some issues could be identified by observation, but it is insufficient to move a conclusion. Resource persons of survey have been provided lot of issues that they have faced.

In this case question is asked for identify the how people are familiar with train seat reservation in Sri Lanka. The response of this question is move to proper way because of most people have made reservation in Sri Lanka Railway. Therefore, these resource persons are very suitable for next part of survey. In Sri Lankan Railway, there are two methods for make seat reservation. They are visiting a railway station and by M – Ticketing mobile service.
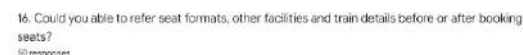
Fig. 11 Main issue in the existing s

This is a huge issue regarding with seat reservation. Because people should have facility to select any seat in the train compartment as they wish and should know food and beverage facility, seat materials and so on before the make a reservation. This facility is very important for long distance trains. Lot of local and foreign travelers use train for long their long trip. Specially these facilities are very important for improve tourism industry in Sri Lanka. Foreigners are not aware with Sri Lankan Trains and this facility make cool for them.
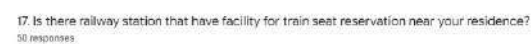
Fig. 12 Percentage of railway stations with a seat reservation system

In Sr Lanka, there are limited number of train stations around fifty have train seat reservation facility. This pie chart shows lot of people have not that type train station near their residence. Therefore, they should visit to that type of train station on another city or should use M – Ticketing mobile service. But there are several issues regarding with M – ticketing service. This service provides by Mobitel and Dialog phone service. Passenger should make phone call from any one of those phone services and their agent make a reservation to passengers according to requirement. But they charge high extra chargers for a minutes of phone call and taxes. Therefore, passenger should pay lot of extra chargers than ticket price. As well as this service have no facility to cancel a ticket.

Fig. 13. Issues that passengers provided (regarding existing reservation process)

The survey gave to a chance to put issues that they have faced at the seat reservation. This figure shows some of them and they are listed follow.

Finally, as the list of issues regarding seat reservation according to passenger's responses.

No proper method to reserve seats.

Unable to see available seats.

High rate of extra chargers in M-ticketing service

Limited train stations with seat reservation facilities.

Passengers should wait long hours to make a reservation in school vacation.

Passengers are unable to see seat format in the train compartment
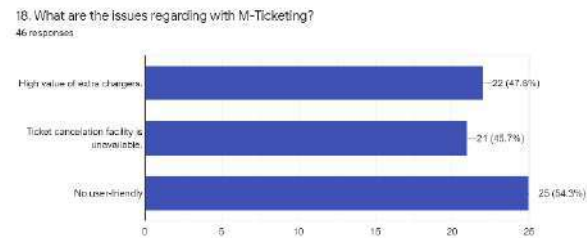
Fig. 14 Issues in the M-Ticketing system

4. Result and Discussion

According to the issues detected above, the existing purchasing train ticket and train seat booking system should change with the new technology. However, the solution of online services made it easier to obtain many things at anytime and anywhere. The leading solution is 'Smart Ticketing and Seat Reservation System.' It provides an alternate and convenient method for train passengers to purchase tickets. An Online Ticketing and Reservation System allows a potential customer to book and pay for a service directly through the system. Before implementing the system, the best way is to identify the system features. The system should have the ability to reduce all common issues that passengers are faced. Therefore, the system should implement features, and that features should prevent passenger issues. This phase discusses system features.

As a result of problem identification, a lot of issues could be identified. Those issues were identified by observations and surveys. The issues of the current ticketing and seat reservation process in Sri Lankan Railway can be finalized as follow.

A. Issues of the ticketing

    process. Long queue.

    People delay reaching train station because of road traffic.

    People delay reaching train station because of off time of workplace.

    Waiting a lot of time for purchasing tickets.

    Insufficient train route data on the ticket.

B. Issues of the seat reservation

    process No proper method to

    reserve seats.

40

Unable to see available seats.

High rate of extra chargers in M-ticketing service.

Limited train stations with seat reservation facilities.

Passengers should wait long hours to make a reservation in school vacation.

Passengers are unable to see seat format in the train compartment.

According to these issues, an online system can be provided proper solutions in a convenient method to reduce above all issues. These issues are detected as common issues in the existing process. The existing process happens manually. Therefore, Sri Lanka Railway has unable to provide good service to their passengers. In the methodology phase, system features have been attached to each issue.

5. Future System Design
Passengers can make a ticket by themselves. There are two methods for it. The first one is passengers can make a ticket by own smartphone by putting start station and destination. After router details and a QR code is provided to the mobile phone and passenger can get into the train station by scanning the QR code. If it is a valid QR code, the platform gate opens. The second one, the situation of passengers don't decide the destination who can provide only start train station and get QR code. But after he gets off the train, he should again scan the QR at the destination. This entire process can do by itself by a smart device such as a smartphone, tablet computer, laptop, or desktop computer. Therefore, passengers no need to wait in long queues for ticketing. They can make a ticket on the way to the train station. Therefore, passengers can enter the train station before just a moment to train leave. As well as they can be shown all train route detail such as train timetables, ticket price, train class by their mobile phone. Therefore, all issues are reduced by the ticketing feature of the Smart Ticketing and Seat Reservation System.

The reset part of the system is the seat reservation feature. It has a lot of functions to make a reservation by the easiest and convenient method. The problem mentioned passengers do not have any method to see all train details before reserving a seat. It is very uncomfortable for local travelers as well as foreign travelers and regular passengers. Smart Ticketing and Seat Reservation System make proper solutions for this problem. all the railway lines of Sri Lanka can be seen. By choosing a railway line, passengers can see trains on that railway line available a seat reservation facility. Then all details are displayed about the selected train. They are train number, available classes, departure time from start station, arrival time to destination, the train station that train stops, train name, number of

compartments, and attached pictures. Passengers can see inside the compartment by those pictures. It is a proper method to get an idea about seat format in the compartment, lavatory facilities, food and beverages, phone charging facilities, window facilities, and other facilities. As well as this part consists of other passenger services of Sri Lanka Railway like observation saloon. Then passengers can reserve seats in different classes. Sri Lanka passenger trains consist of three classes as first-class, second class, and third class. Seats are numbered, and available seat numbers are presented to the passenger. It means those seats had not been reserved. Passengers can reserve one or more seats. After reserved seats are locked, and another passenger is unable to reserve locked seats. This is the process of seat reservation. As well as anyone who wants to cancel a reservation, there is a function for doing it. However, refund money only eighty percent of ticket value. Above all, functions are essential for the tourism industry because there is no method for foreign travelers to make their train journey properly. Not only for foreigners, but local travels can also make their journey correctly.

Smart Ticketing and Seat Reservation System is developed as a web application and mobile application. The system will be implemented as a mobile application and web application. Sprint boot, Angular, Ionic, and MySQL technologies are used to develop the entire ticketing, reservation, and other applications.

6. Conclusion

In this research paper, we have discussed some problems of the current manual railway system of Sri Lanka and proposed a Smart Ticketing and Seat Reservation System; the underperforming railway transportation in Sri Lanka is not still running on the self-seat reservation system. The Sri Lankan railway has been following the same traditional way of issuing tickets. According to that process, passengers need to visit the counters in railway stations, pay for the tickets, and get the tickets. The tickets currently issued by the Sri Lanka Railways are valid only from the date of issue and to the given destination only. Also, the current ticket reservation process of Sri Lanka Railways can be identified as a primary level system. Therefore, passengers cannot know about their seats and ticket prices and train details, train destinations. In this research, all issues were identified by observations and an online survey.

Before implementing the online ticketing system, system features should be identified. Because of system features mainly provide better solutions for difficulties of current train seat reservation system. Before identifying the system features, the better way is first to identify the current difficulties and problems of the current ticketing system. Because of it is very important for implement the system features. Observations are most important for identifying issues at an initial level. But observations are insufficient to detect all issues. Therefore, the online survey grabbed lot of issues that passengers have faced. There is different kind of issues. Some of them are long queues at the ticketing,

there is no method to make a reservation by self, the limited number of train station with seat reservation facility, unable to see seat format in a train compartment before making a reservation and so other issues. Finally, this research proposed system features as the solutions for all issues and difficulties. The proposed features make a convenient and easiest method for ticketing and seat reservation. After implementing the system passengers can make a reservation or buy a ticket by themselves.

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Comparison Analysis and Systematic Study on Secure Transmission of Data in the Cloud Using Steganographic Techniques and Cryptographic Algorithms

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Abstract: *Data and information can be considered the most precious assets in electronic communication systems, but security has become a struggle in this competitive world. Cloud computing has emerged as the most exciting technology for on-demand computing. It is now used by the military, healthcare, education, finance, and various other organizations to handle their large volume of information. Cloud computing has many benefits, including efficiency, high performance, scalability, accessibility, backup, and recovery. Security is a primary concern in cloud computing because everyone in the organization shares the same cloud platform. The most significant issue for the user is securely saving, retrieving, and transmitting data through the cloud network and storage. Cryptography and steganography can be defined as the most popular techniques that can be used to enhance data security. Cryptography scrambles the messages into an unintelligible format, while steganography hides the message as it is not observable to the attacker. High-level security is given for both the sender and the receiver inside the cloud platform when cryptography is used along with steganography. This paper analyzes the performance of cryptographic and steganographic techniques and suggests the best hybrid cryptographic algorithms and multilayer steganographic techniques that can be combined for efficient and secure data transmission in the cloud. This proposed system will provide availability, integrity, authenticity, confidentiality, and non-repudiation to the data and information.*

Keywords: *Asymmetric Key Cryptography, Cryptography, Image Steganography, Steganography, Symmetric Key Cryptography*

1. Introduction

Cryptography is a method of converting readable information into an unreadable format and vice versa. Cryptography consists of terminologies, namely plain text, ciphertext, encryption, and decryption. Encryption is the process of converting a regular communication (plaintext) into a meaningless message (ciphertext), while decryption is the process of returning a meaningless message (ciphertext) to its original form (plaintext). Symmetric key cryptography (private key cryptography) encrypts plaintext and decrypts ciphertext using the same cryptographic key. Asymmetric Key Cryptography (also known as Public Key Cryptography) has two keys, namely a private key and a public key. The message will be encrypted by the sender using the receiver's public key. Then the message will be decrypted by the receiver using his or her private key.

Steganography is an information-hiding technique that uses cover objects to send messages between a sender and a recipient without arousing suspicion and without allowing anybody else to know whether the communication is taking place. Steganography can be classified into five types depending on the nature of the cover object, namely text, video, audio, image, and network steganography. Text steganography secures a message by hiding it in a particular letter of each word or rearranging the text without altering its meaning. Audio Steganography makes use of the human ear to conceal information secretly. Video Steganography camouflages the secret message into a digital video. Network Steganography is hiding information using a network protocol as a cover object, such as UDP, IP, TCP, ICMP, etc. The secret message is hidden as an image in the cover object using Image Steganography.

Both steganographic and cryptographic approaches are used to secure data. The difference between steganography and cryptography is that cryptography scrambles a message such that it cannot be deciphered by unauthorized users or third parties. Steganography camouflages to hide the existence of a message; then anyone can know there is a concealed message hidden in a cover object. Steganography provides confidentiality and authentication only, while cryptography provides confidentiality authentication, data integrity, and non- repudiation.

Section II of this paper deals with the literature review on the research related to data and information security using steganographic or cryptographic techniques. Section III provides the proposed methodology; section IV presents the discussion, and section V presents the conclusion.

2. Literaruere Review

This section deals with the vast number of research related to secure and efficient data in the cloud using steganographic or cryptographic techniques.

Research on performance analysis of Symmetric Cryptographic Algorithms (Vyakaranal and Kengond, 2018) has discussed different symmetric key cryptographic algorithms, namely Data Encryption Standard (DES), Triple Data Encryption Standard (3DES), Advanced Encryption Standard (AES), and Blowfish by analyzing encryption time, decryption time, avalanche effect, energy consumption, memory usage, and throughput by implementation using java. The results of the study reveal that the Blowfish algorithm requires less memory and high throughput, and it needs less time for the encryption and decryption of files when compared to other algorithms. Moreover, the study depicts that the blowfish algorithm is well suited for situations where memory and time usage play a significant role, while the AES algorithm is ideal for applications where strength and minimal energy usage is an important aspect. In addition, DES is the best algorithm for applications that need security with minimum bandwidth consumption.

A study (Shakti,2015) was conducted to analyze the performance of asymmetric cryptographic algorithms namely RSA (Rivest, Shamir, Adleman), Diffie-Hellman, El Gamal, Elliptic-curve cryptography (ECC), and Digital Signature Algorithm (DSA) algorithms. The results of the study have concluded that each algorithm had its advantages and disadvantages. Furthermore, the experiments prove that the efficiency of RSA is lower than the ECC algorithm. In addition, El Gamal is slower and DSA needs lots of time to authenticate and the verification process has complicated remainder operators. Moreover, the authentication procedure of the Diffie- Hellman algorithm is very low. Finally, the study concluded that all of the algorithms' performance is dependent on the application they choose.

Research (Jaspin et al., 2021) proposed a method to provide high security to the cloud platform using double encryption techniques. The proposed system combined the AES symmetric cryptographic algorithm and RSA asymmetric cryptographic algorithm to increase the security and reduce the drawbacks of using those algorithms separately. The results of the study depict that the proposed methodology takes the least time for encryption runtime and decryption runtime of the text file. In addition, the proposed system provides a higher level of security with resistance against propagation errors compared with DES, Blowfish, RC5, and 3-DES algorithms. The study (Timothy and Santra,2017) aimed to create a new security solution to protect the data in the cloud with a hybrid cryptosystem. The proposed system combined the Blowfish symmetric cryptographic algorithm to ensure the confidentiality of data and the RSA asymmetric cryptographic algorithm to guarantee the authenticity of data. In addition, this system consists of Secure Hash Algorithm-2 (SHA-2) to ensure data integrity. Therefore, the study has revealed that this hybrid cryptosystem provides high security for data transmission over the cloud. A review on data and information security in cloud computing using steganography (Alkhamese et al., 2017) depicts the types of steganography with a high focus on image steganography. The paper highlights the techniques of the Discrete Cosine Transform (DCT) and Least Significant Bit (LSB). Performance evaluation of the spatial domain and transform domain techniques of image steganography exposed the fact that spatial domain, the LSB technique, is mostly used to hide data that has a higher payload capacity, but it's easily encoded and detected by attackers. In the transform domain, the DCT technique is very complicated and has a low payload capacity compared to the LSB technique, but the DCT technique provides more security than the LSB technique. Furthermore, this research suggested that future work could combine LSB and DCT approaches to avoid the drawbacks that arise when applying these techniques individually and to increase the secret message's security.

A study (Chandran and Bhattacharyya, 2015) analyzed the performance of Least Significant Bit (LSB), Discrete Cosine Transform (DCT), and Discrete Wavelet Transform (DWT) steganographic techniques. The performance analysis of the above-mentioned steganographic techniques was carried out by analyzing the parameters namely invisibility, robustness, Peak Signal to Noise Ratio (PSNR) and Mean Square Error (MSE). Invisibility is the similarity of the stego image, and the original image. Robustness means the ability of the secret message to remain unchanged even if the stego image was subjected to changes. The square of the error between the cover picture and the stego image is MSE, while the greatest signal-to-noise ratio in the stego image is PSNR. As a result of the experiments, it can be concluded that the DCT algorithm is the most suitable technique compared with the DWT and the steganographic techniques. Research (Singh, et al., 2018) was conducted to analyze the performance of the LSB and modified DWT algorithm for image steganography. According to the results obtained by testing five RGB image sets, the researchers concluded that the modified DWT algorithm has a higher PSNR value, high security, invisibility, and robustness compared with the LSB algorithm. Furthermore, it was concluded that the overall performance of the modified DWT algorithm is better than the LSB algorithm.

Research (Biswas et al., 2019) has exposed an efficient algorithm to provide the confidentiality, integrity, and authentication of data and information using hybrid cryptographic and steganographic algorithms. Hybrid cryptography was used in this study, including the AES symmetric cryptographic method and the RSA asymmetric algorithm. The LSB steganographic approach was then used to embed the hidden message.

The study (Palathingal et al., 2019) focused on a cloud data security model using cryptography and steganography. Through the proposed system, data will be encrypted using the RSA asymmetric cryptographic algorithm. After that, the secret data will be embedded using Discrete Wavelet Transform (DWT) technique. Then the file will be uploaded to the cloud. The results of the proposed system will be provided with augmented security to the data that can be used anywhere without qualms.

Another research (Naidu et al., 2019) presented a multilayer security system to protect and hide multimedia data using cryptographic and steganographic techniques. Here, DES symmetric cryptographic algorithm is used as the symmetric cryptographic algorithm and the LSB technique is used to hide the secret message or data. Furthermore, the study has revealed that steganography is a highly effective technique used for confidential communications. Aside from secret communications, the researchers determined that the combination of cryptography and steganography may be utilized for a variety of others.

3. Proposed Methodology

This system will be developed by combining the blowfish symmetric key cryptographic algorithm, Elliptic-Curve Cryptography (ECC) asymmetric cryptographic algorithm and RSA asymmetric cryptographic algorithm as the hybrid cryptosystem to perform double encryption to secure the data.

Then Discrete Cosine Transform (DCT) and Least Significant Bit (LSB) image steganographic techniques are combined to create a multilayer steganographic algorithm to hide the encrypted file inside a cover image to provide extra security.

This system consists of 2 processes as Encryption & Embedding Process and the Decryption & Extraction Process.

A. Encryption & Embedding Process

Here Figure 1 shows the encryption and embedding process of the file to the cloud. If the user is new, the user should register and log in to the system. Then the user should choose the file to be uploaded to the cloud and then the file will be automatically encrypted using the blowfish symmetric key cryptographic algorithm, Elliptic- Curve Cryptography (ECC) asymmetric cryptographic algorithm, and RSA asymmetric cryptographic algorithm as the hybrid cryptosystem to perform hybrid encryption to secure the data. Then Least Significant Bit (LSB) image steganographic technique is combined to create a multilayer steganographic algorithm to hide the encrypted file inside a cover object to provide extra security.
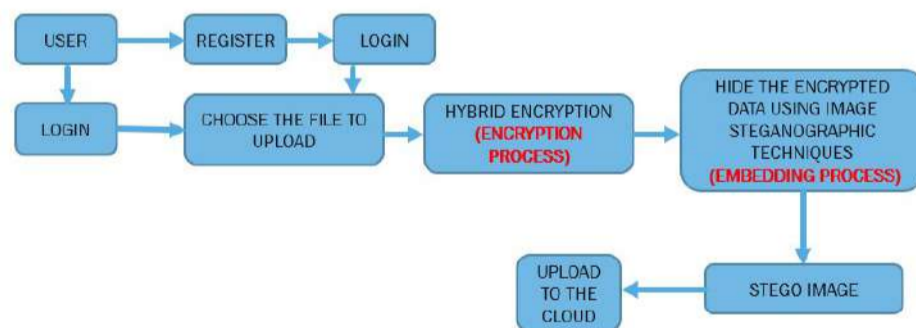

Figure 1. Encryption and Embedding Process
Source: Author

B. Decryption & Extraction Process

Here Figure 2 shows the decryption and extraction process of the file to the cloud. If the user is new, the user should register and log into the system. Then the user should choose the file to be downloaded from the cloud and then the steganographic image will be extracted and get the encrypted file in the extraction process. Next, the encrypted file will be decrypted in the decryption process
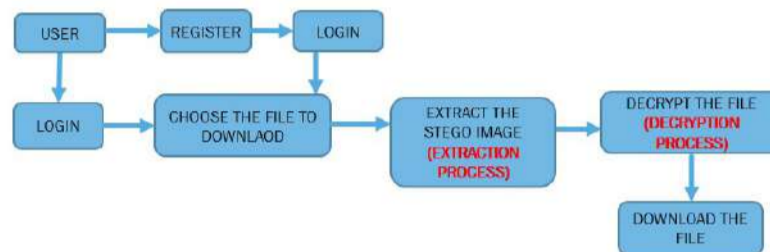

Figure 2. Decryption and Extraction Process
Source: Author

C. Key Management Server

The generated private key will be stored in another file and will be sent to the cloud Key Management Server. When a user decides to download a file, must first log in to the system and then provide the key to gain access to the storage. This key will be provided via a secure channel to the authorized user. The key is generated by using a hash function to the private key file. After the user enters the key, the system compares the produced key to the key entered by the user. If they are identical, the user obtains access to the private key and can decrypt the file.

4. Discussion

To minimize data breaches, reduce the danger of data exposure, and maintain regulatory compliance, data security functions are deployed. The purpose of data security in any company is to ensure that private data is used safely and securely while minimizing the risk of exposure.

In recent years, people used symmetric or asymmetric cryptographic approaches to increase the efficiency and security of data transmission inside the cloud. But with the development of technology hackers easily broke the algorithms and decrypt the ciphertext. As a solution for using symmetric or asymmetric cryptographic algorithms individually, the researchers proposed systems to combine symmetric and asymmetric algorithms to enhance the security of the cloud. Therefore, the double encryption techniques using both symmetric-key algorithms and asymmetric key algorithms help to reduce the drawbacks that arise when they are used separately. In the double encryption process, the two-time encryption and decryption process is performed using symmetric and asymmetric algorithms. With technological advancement, cryptography was used along with steganography to give high security to the cloud. The fundamental drawback of cryptography is that anyone can understand there is that secret communication is taking place. As a result of that, hackers try to access the data by breaking the secret key. But when we use steganography, no one is aware of the ongoing secret communication. In this case, the secret message can be hidden inside audio, text, network, video, or image. The drawbacks that arise from using only steganography to hide the secret message are steganography doesn't provide non-repudiation, and authenticity, it provides only confidentiality to the data. Therefore, to provide high security to data when saving, retrieving, and transmitting in the cloud, it is best to choose the best hybrid cryptographic algorithm and multilayer steganographic algorithm. Table 1 shows the statistics of 6 cloud platforms used in the world, the security mechanisms used, and the latest attacks faced by them.

Table 1. Comparison of cloud platforms

Reference	Cloud Platform	Security Mechanism	Latest Attack Faced
(Nicholson,2020)	AWS (Amazon Web Services)	The AES-256 algorithm is used to encrypt data in AWS, including server-side encryption in Amazon Simple Storage Service (S3)	Amazon Web Services (AWS) claimed the largest Distributed Denial of Service (DDoS) assault on records at 2.3 Tbps in 2020
(Cimpanu,2021)	Microsoft Azure	The Advanced Encryption Standard (AES) encryption used by Storage Service Encryption is 256-bit. Transparent encryption, decryption, and key management are all handled by AES.	In early August 2021, a 2.4 terabits-per-second (Tbps) distributed denial of service (DDoS) assault was launched.
(Hope,2021)	Google Cloud	The Advanced Encryption Standard (AES) algorithm is used by Google to encrypt data at rest. By default, all data is encrypted with AES256 at the storage level. When encrypting data in the Cloud, GCP uses DEKs and KEKs, which are utilized and stored via Google's Key Management Service (KMS) API.	Google discovered that 86 percent of the 50 recently hacked Google Cloud instances were utilized for bitcoin mining.
(Goud,2021)	IBM Cloud	use 256-bit AES algorithm keys to data encryption.	Cyber-attacks exposed more than 8.5 billion records in 2019, according to IBM's X- Force Threat Intelligence Index 2020. As a result of faulty cloud servers and human mistakes, hackers obtained access to around 7 billion records.
(Staff, 2016)	Alibaba Cloud	An industry-standard AES-256 algorithm is used to encrypt data and associated keys. The overall key management architecture of Alibaba Cloud follows the guidelines in (NIST) 800-57 and employs cryptographic methods that meet the (FIPS) 140-2 standard.	In 2015, Chinese hackers attempted to use Alibaba Group Holding Ltd's own cloud computing service to get access to over 20 million active accounts on the Taobao e- commerce website.
(Whiting, 2019)	Oracle Cloud	The Transparent Data Encryption (TDE) Algorithm encrypts data at rest in Oracle Databases in a transparent manner. It prevents the operating system from accessing Database data stored in files without altering how SQL is used to obtain the data by applications.	In 2018, the Oracle cloud was hacked, and the attacks appeared to be intended at the company's Micros Systems credit card payment system.

Table 1 shows that most cloud platforms encrypt data using the AES or TDE algorithms but according to the statistics, cloud systems are vulnerable to massive data breaches.

Table 2 shows the comparison of mainly using symmetric key cryptographic algorithms namely AES, Blowfish, DES, 3-DES, and RC5.

Table 2. Comparison of symmetric and asymmetric cryptography

Parameters	AES	DES	3-DES	RC5	BLOWFISH
Key size and no: of rounds	128,192 and 256 bits. 10,12 and 14 rounds	64-bit key. 16 rounds	112 bits or 118 bits & 48 rounds	0 to 2040 bits & 12 rounds	32-448 bits 16 rounds
Block size	128 bits	64 bits	64 bits	32, 64, or 128 bits	64 bits
Security	Secure	Not secure	Better than DES	Partially secure	Very Secure
Speed	Fast	Very slow	Slow	Slow	Fast
Data Confidentiality	Yes	No	No	No	Yes
Data Integrity	Yes	No	No	No	Yes
Cipher Text Size	Similar to plain text	Larger than plain text	Larger than plain text	Larger than plain text	Same as plain text
Characteristics	Replacement for DES, Excellent security,	Not much secure but flexible	Good security, Flexible	Not much secure, simple, consume less memory	Excellent security, Flexible

Source: (Vyankaranal et al., 2018)

According to the previously discussed literature review and the comparison of the above-mentioned symmetric cryptographic algorithms, the best symmetric cryptographic algorithm that can be used is the Blowfish algorithm.

Table 3 shows the comparison of mainly using asymmetric key cryptographic algorithms namely Diffie-Hellman, RSA, ECC, EL Gamal, and DSA algorithms.

Table 3. Comparison of symmetric and asymmetric cryptography

Parameters	RSA	DSA	ECC	Diffie-Hellman	El Gamal
Key size	>1024	1024	Calculates key from Elliptic curve equations	1024 to 4096	1024
Efficiency	Not much efficient	Faster	Very fast & efficient	Not very efficient	Faster & efficient
Attacks	Brute force attack, a	The attacks may depend on	Doubling attack	Vulnerable to attack	Vulnerable to Meet-in-

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	timing attack	implementation		the-middle	middle attack
Advantage	The private key is difficult to generate from the public key and modulus. As a result, it delivers a high level of security.	Provide authentication and non-repudiation	Uses elliptic curve equations theory	The symmetric key is short in length (256 bits); Therefore, the algorithm is quite fast	El Gamal encryption is different from El Gamal's signature. (Therefore, no confusion occurred)
Disadvantage	The complexity of generating keys is difficult	Needs lots of time to authenticate and the verification process has complicated remainder operators	It is complex, implementation is difficult	The authentication procedure is very low	Slow speed and the message is doubled in size as a result of the encryption procedure.

Source: (Shakti, 2015)

Table 4 shows the comparison of main image steganographic techniques namely LSB, DCT, and DWT.

Table 4. Comparison of Image Steganographic Techniques (Machit et al., 2019)

Parameter	LSB	DCT	DWT
Invisibility	Low	High	High
Robustness	Low	Medium	High
Payload	High	Medium	Low
Complexity	Low	High	High
Peak Signal to Noise Ratio (PSNR)	Medium	High	Low
Mean Square Error (MSE)	Medium	Low	High

According to the previously discussed literature review and the comparison of the above-mentioned image steganographic techniques, the best hybrid steganographic technique that can be used is the combination of LSB and DCT algorithms. LSB technique has low invisibility and robustness while DCT has high invisibility and medium robustness. The MSE value of DCT is low but LSB has a medium MSE value. Therefore, the combination of DCT and LSB techniques can reduce the drawbacks of using those algorithms separately.

5. Conclusion

Cloud security is a subset of cybersecurity that deals with policies, procedures, and technologies for safeguarding cloud computing systems. It protects data in the cloud and other digital assets from data breaches, distributed denial of service (DDoS), hacking, malware, and other cyber threats. This paper suggested using cryptography along with steganography to provide high-level security to the confidential data inside the cloud platform. Moreover, this paper discussed the concept of cryptography, the performance of different symmetric and asymmetric key cryptographic algorithms, the concept of steganography, and the performance of different steganographic techniques. The facts discussed above proved that the blowfish algorithm has better performance when compared with other symmetric key cryptographic algorithms (DES, AES, 3-DES, and RC5 algorithms). In addition, the ECC algorithm has better performance when compared with other asymmetric key cryptographic algorithms (RSA, ECC, Diffie-Hellman, El Gamal, and DSA algorithms). Furthermore, it can be concluded that the combination of LSB and DCT image steganographic techniques can provide extraordinary security when hiding the file inside a cover image. The blowfish symmetric key cryptographic technique and the ECC and RSA asymmetric cryptographic algorithm can be combined as a hybrid cryptosystem to perform double encryption to secure the data. Then LSB and DCT image steganographic techniques can be combined to create a multilayer steganographic algorithm to hide the encrypted file to provide extra security. This proposed system will provide

availability, integrity, authenticity, confidentiality, and non-repudiation to the data and information at same time.

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Role of Hydro GIS Tools in Hydrological Modelling and Urban Flood Management: A Literature Review

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Abstract: *Hydrological modelling and urban floods have a strong relationship as flood management is based on hydrological calculation. GIS assists this relation by providing an easy environment to carry out difficult and time-consuming steps of hydrological calculations. However, when developing automated GIS tools for the above process, there are no guidelines available to manage the software project easily. Then developing a comprehensive guideline requires to clearly understand of the role of GIS in the urban flood and hydrological modelling relation. The present work carried out an in- depth study on; flood, land management, hydrological modelling and GIS assistance to hydrological modelling to understand the role of hydro GIS tools in urban flood management. It used the semi-systematic literature review method to review the gathered knowledge. Through the analysis, it found a close relationship between flood and land management, specially in urban areas. Further, it found that now GIS is assisting in performing the major functions of hydrological models than the inception, and the HydroGIS term has been introduced to identify the software tools that assist flood management through hydrology modelling. Further, it has been understood that HydroGIS tools are employed in local-level flood management activities and utilised by non-technical decision-makers for day-to-day activities. Hence the HydroGIS tools can be introduced to the local level authorities as an interface to perform complex hydrological processes when land management decision-making.*

Keywords: *Urban Flood, Hydrological Modelling, state-of-art Review, HydroGIS tool, Flood Management*

1. Introduction

A. Land and water

It has studied that, the cities are getting crowded and new urban areas are being created as a result of man-kind attention change from agriculture-based economy to industrial-based economy (Henderson, 2003; National Geographic, 2020; Weeks, 2010, p. 2). According to the statistics in 2018, 55% of the world population lived in the urban area, but UN predicted that it will reach to 78.3% by 2045-2050 (UN, 2018b, a). Same way, it has predicted that the global urban land cover would be increased to approx.

1.5 million km^2 by 2030 (Seto et al., 2011). Considering the total world land area of 148.94 million km^2, this is only 1.025%. Hence, it shows that urban population densities are getting more compressed. This situation increases the complexity in land management as repercussion of a simple failure effects on large population.

One of such critical decision making is flood management, as the cities are evolved around water ways such as rivers and bays which prone to flood. Further the notable effect of urbanization on land cover and land use resulted high direct runoff creating flood situations, while high population density increases flood risk and damage (Archer & Fowler, 2021; Feng et al., 2021) . Then the flood managers obviously pay the attention to land management and other integrated approaches when flood management. As well analysing the available flood data on four leading flood effected countries, it found that the damage to the people is reducing but the damage to economy is increasing (Figure 1). Hence, now the flood is becoming as a challenge to economic growth of most of nations (Miller et al., 2014; OSPHP, 2014; Sun et al., 2011; World Bank, 2016).

Then todays passion is to manage the flood through integrating land and stakeholder management approaches and institutions such as Integrated Water Resource Management (IWRM), Organisation for Economic Co-operation and Development (OECD) and Low Impact Development (LID) (OECD, 2015; Piyumi et al., 2020; WMO, 2013).
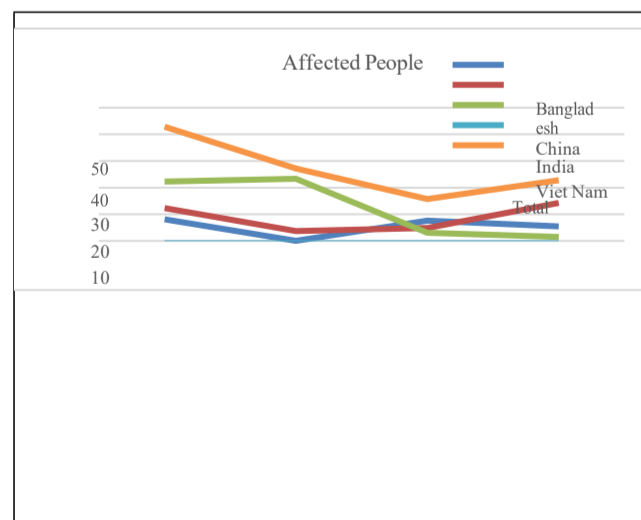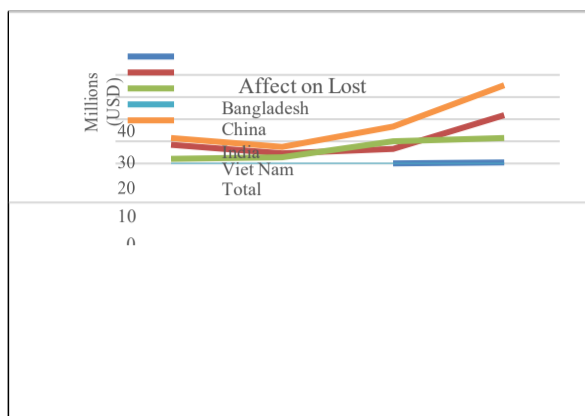
Figure 1: Comparison of flood affect
Source: created using (EM-DAT, 2020)

A. Water and GIS

Flood is natural phenomena which gather excessive water than normal situation. Hence, to manage the flood it requires to manage the water. For the purpose, the decision makers need to understand the natural water behaviour, or scientifically the hydrological cycle. Then to understand the water behaviour in different situation, the hydro models are being developed (Solomatine and Wagener, 2011; Devi, Ganasri, and Dwarakish, 2015). The curiosity on water led to human to understand the water cycle process since ancient times, i.e., 1200 B.C. However, since A.D. 1800s, the water experiments started to flourish, and hydrologists have been utilised such timely-tested hydrologic models to water resource management. Further, these hydrological models are now considered as mature to provide accurate flood management information (Chow, Maidment, and Mays, 1988, pp.12–17).

However, when consider the three main components in water cycle in urban situation (precipitation, runoff, and infiltration/evaporation) (Jacques, Stergios, and McPherson, 1980), the land cover critically effect on runoff, and infiltration. Hence, when hydrological process, it required the accurate information regarding the land cover conditions to calculate accurate output. However, the main difficulty is, the accuracy is dependent on the resolution of spatial information. This required higher computational power as it needs to manipulate high-resolution and large amount of spatial data.

In such scenario, the development of Geographic Information Systems (GIS) which evolved about a half-century ago could be able to efficiently handle the foresaid problems and simulate the models dynamically. Hence GIS become a one of the tools of hydrology modellers and further flood managers (Ogden et al., 2001).

Even though GIS had the poor usability problems, the technological boost has solved all those presently (Barik et al., 2016; Bhor, 2015; Chappell, 2010; Goodchild, 2016; Kar et al., 2016; Yang et al., 2017). With the advancement of GIS in handling complex and massive data sets (Devi,

Ganasri, and Dwarakish, 2015; Coskun et al., 2010), the spatial-oriented distributed hydrological models now become a lumped model to the users which is essential in today's water management decision-making functionality (Alcaraz et al., 2017; Paudel, 2010; Pullar & Springer, 2000; Shamsi, 1999).

Therefore, the now, the GIS has become a sine-quo-none component of the Hydro model and the term 'HydroGIS' refers to a common ground between hydrology and GIS components. The HydroGIS model is preferred to the hydrology and GIS model integration for water simulation. HydroGIS tools are designed for practising scientific hydrology models using the spatial information management process of GIS (M. J. Clark, 1998). HydroGIS tools, on the one hand, provide GIS capability to capture, compute, and deliver inputs to Hydrologic models. On the other hand, it captures, computes, and delivers the Hydrologic model outputs to users as spatially distributed map-based information (Maidment, 1996; Pradeep & Wijesekera, 2020a).

C. Problem Statement

Then as described, the land, water and GIS are relating each other's, and it understood that today hydrological models must be integrated with the GIS while making decisions in flood management. However, this critical workflow is needed to be automated on the platform of GIS (Pradeep & Wijesekara, 2018). Nevertheless due to computing discipline guidelines, it requires a suitable modelling framework to automate the workflow related to input-process-output of Hydro-GIS model (Pradeep & Edirisuriya, 2021; Pradeep & Wijesekera, 2021). Then, the fundamental requirement in development of any framework is understand the state-of-art in the research area.

Therefore, it searched the review-articles for the year 2022 (up to June) via Google scholar for AND joining key words of "GIS", "hydrological model", "flood management" and "Review". It resulted 162 articles, however it found that only seven articles are related to the present scenario. Nevertheless, those seven are on hydrological modelling practices for flood management, applications of GIS in water resources, disaster management and flood risk management, urban flood models in flood mitigation strategies, hydrological modelling practices for flood management, flood modelling for urban flood risk management and GIS technology for mapping and modelling urban floods. Then, as those articles are in out of focus, it required to review the available knowledge on the present interest.

D. Aim

Then the aim of the present work is to review the role of GIS tools in flood management and hydrological modelling. Then such understand will provide the required background

information to build a suitable framework for Hydro-GIS model development.

2. Methodology

Due to the present research attention is fallen on multiple disciplines it decided to use semi-systematic literature review method (Snyder, 2019). There are three research questions were developed and utilised to collect literature through searching the relevant keywords for each question. The questions are (1) What are the interesting relations between Flood and land management, (2) What are the interesting relations between Hydrological modelling and GIS, and (3) What are the importance of GIS tools in flood management. Then the collected answers were divided in to five main themes such as (1) Flood, (2) Land, (3) Hydrological Modelling, (4) GIS tools, and (5) Implementation of Hydro GIS tools; and developed the review based on those themes.

3. Literature Review

A. Flood

The floods are events of the natural water cycle and based on the floods' nature, those are classified into 6 different types, as shown in Table 1. According to Kocornik-Mina et al., (2016), the urban flood is the most important to humans as those reduce the cities' annual economic activities by 2 to 12%. Further several studies retrieval that, the cities are always subjected to flood with flood damage worth more than Trillion USD and devastating factor to economies (OSPHP, 2014; Sun et al., 2011; Miller et al., 2014; Gunaruwan, 2016; Huizinga, Moel, and Szewczyk, 2017; World Bank, 2016).

Table 1: Different flood types

Types of flooding	Causes (Natural)	Causes (Human activity)	Onset time Duration
Urban flood	All other floods	Drainage problems, Land permeability, Lack of management	Varies. Hours - Days
Pluvial and overland flood	Extreme rains, Jamming in water bodies, landslides	Land cover changes	Varies. Varies
Coastal (Tsunami, storm surge)	Extreme Natural reasons	No direct action but harm for Coastal living	Rapid. Minutes to Months
Groundwater	Increase in the water table	Influence on natural aquifers	Slow. Longer
Flash flood	Quick release of blocked streams	Collapses in retaining, Obsolete Infrastructure	Rapid. Few hours
Semi-permanent flooding	Sea Rise, Land Subsidence	All the above	Slow. Long/ permanent

Source : (Jha et al., 2012, p. 57)

When considering the fundamental circumstances of floods, climate change is the most prominent, as human activities contribute to global warming and promoting climate change such as CO_2 emission and global greenhouse gas (GHG) emission (Aalst, 2006; Milly et al., 2002; World Bank, 2019).

However, some studies show that, flood is a natural phenomenon to manage the equilibrium. Nevertheless, human tend to locate in flood plains and their activities on behalf of economic reasons such as businesses and poverty, block the natural cycle. Then it develops floods even in regular rain events (Lee & Jung, 2014; Loucks et al., 2006). Even though there are concepts, policies, and regulations to control the human activities, due to less integration of governors and inhabitants, and gaps, political influences and poor enforcement of the available law structure; those are limited to documentation (Baker et al., 2014; Jha et al., 2012; Zhou, 2014).

B. Land

The surface runoff is the main source to flood and proved that there is a relation between urbanisation and the surface runoff increase (McGrane, 2016; Odunuga, 2008; Prachansri, 2007; Shrestha, 2003; Wakode et al., 2018). It has identified that surface runoff increasing activities in urbanizations are cover with impenetrable materials over the land, changes made to soil, slope and specially divert natural water paths. (Marshall & Shortle, 2005, pp. 63–70; Prachansri, 2007). Then those changes are also observed as 3 spatiotemporal changing patterns; "grow", "shrink", and "normal" (Ping, Xinming, and Huibing, 2008). However, according to the universal truth, the water is flowing from high grounds to the low ground under the gravitational influence, but not under the human's importance. Hence, when manage the flood water it required to consider both the natural and human land scenarios (Douglas et al., 2019, p. 30; IWA, 2013).Therefore, land management become a key activity in flood management and requires hydrologically planned land management (Pradeep & Wijesekera, 2020a).

C. Hydrological Modelling

Then the foundation of "hydrologically-planned land development" is reliable water flow calculation method and hydrologic modelling assist such (Burges, 1986; Ogden, 2021). As the present scenario is about urban land management, the urban hydrology, which consider the water relationship with human needs picked the attention (Shrivastava, 2016). Unlike general hydrological modelling, the urban hydrological modelling appeared in later in 1960's for urban land management (Leopold, 1968). Since then, researches are observed on the subject such as Mcpherson and Schneider, (1974) attempted to identify the problems on the urban watershed, Chan and Bras, (1979) analysed the flood volumes in urban extends, Jacques, Stergios, and McPherson, (1980) modelled the runoff process of the urban and Maidment and Parzen, (1984) analysed the urban water

use. Since 1980s urban water management become a popular study and being treated as a most critical activity for modern water management (Chow et al., 1988; Shaw, 1994; Smart & Herbertson, 1992). Fuelling with the swift urbanisation since 1990s, global level initiatives such as UNESCO Urban Water Management Program (UWMP), have been set up to manage urban water to share the knowledge among nations (Makarigakis & Jimenez-Cisneros, 2019).

There are two types of hydrological models; lump and distributed. The distributing modelling are more realistic but due to the land's undulation nature; it required higher resolution in spatial data. With the increased resolution it gives more accurate results but reduces the model performance (Becker & Serban, 1990; Ficchì et al., 2016; Ichiba et al., 2018). To increase the model performance it required to make the summation and averages of the parameters, then it generates considerable deviations from the reality (Afouda & Szolgay, 1987; Becker & Serban, 1990, p. 26). Even though it created a distributed type of output with higher effort, then calibrations required same effort to be paid again. Hence the trial-and-error processes, communicate the output to non-technical persons and improved visual outputs are become the hydro modelling a tedious and unthinkable work (Becker & Serban, 1990; Eger et al., 2017; Fatichi et al., 2016).

D. GIS Tools

However, utilising the technologically advanced GIS, those tedious task could successfully managed. Todays GIS is capable to model the multi-criteria and multi-model analysis and those are used as process automaton agents, data handlers, and visualisers in hydrological modelling (Cordão et al., 2020; Kubwarugira et al., 2019; Moncada et al., 2020; Ogden et al., 2001; Ramkar & Yadav, 2019; H. T. Su et al., 2018; W. Su & Duan, 2017; Thakur et al., 2017). Further It evaluated 10 key research in the hydrological modelling since 1986 to 2020 for assess the level of GIS assistance in hydrological process as shown in Table 2.

Consider the close bond and attractive scientific models' integration between the Hydrological model and GIS: The HydroGIS93 conference in April 1993 at Vienna introduced the term "HydroGIS" (Kovar & Nachtnebel, 1993). Even though the ample number of tools are developed using hydro and GIS, the term rarely appears in the articles (such as Nhan et al., 1995; and Shokoohi, 2007). Then it observed that Pradeep and Wijesekera have introduced the term "Hydro-GIS tool" for flood management software tool, which facilitates the local authority to manage the urban land with the flood management capability enhanced by GIS and hydrology models (Pradeep & Edirisuriya, 2021; Pradeep & Wijesekara, 2017, 2019, 2015a, 2015b; Pradeep & Wijesekera, 2011, 2012, 2014, 2016, 2018, 2020a, 2021, 2020b).

E. Implementation of Hydro GIS tools

Water is flowing over the ground without considering the man maid boundaries. Hence in most countries the flood water management is distributed to different administrative levels, based on the geographical area such as (1) Local, (2) Regional, and (3) National levels (Zermoglio, Scott, and Said, 2019, p.67). Apart from that when the water flow over the nations the Transboundary level has introduced as the fourth to the list (APFM, 2013, p. 2). In urban scenario, the local level is interested and stakeholders at the level are, (1) The individuals: Responsible to adhere to the local government's rules and regulations on the lands and water, (2) local decision-makers / Water Service Provides (WSP) control and permit individual activities, and (3) the Water Resource User Association/Water User Association (WUS), is a local group of people (such as farmers) who negotiate with WSP on water and land demands. The WUS provides the link between stakeholders of regional levels (Dukhovny et al., 2009; Gandhi et al., 2020; IUCN, 2015). However, at the chain of command, the local level becomes the operationalisation agent of the management options made by the upper levels. Hence day to day quick decision making has to be done by local levels under the rules, regulations and norms imposed by regional or national level. (Bandaragoda, 2000, p. 9; IWRM, 2009, p. 5).for an example, when consider Sri Lanka, the local authorities such as Municipal councils (MC), Urban councils (UC), and Pradeshiya Sabha (PS) are given the controlling power of all the lands and erections, by the law to look after the water and other resources of the area (Urban Councils Ordinance, 1940; Municipal Councils Ordinance, 1947; Pradeshiya Sabhas Act, 1987).

The regional level decisions are based on the states or basins level (Gandhi et al., 2020, pp. 9–18) while the national-level authorities manage the nation-wise policies on water. (Bandaragoda, 2000; IUCN, 2015; Song et al., 2010; Zermoglio et al., 2019). In transboundary level, the nations among the watershed are responsible for collectively make decisions on water (APFM, 2013).

4. Results and Discussion

A. Urban Flood Management and Land Management

It found six types of floods (urban, coastal, groundwater, flash, semi-permanent, and pluvial & overland) and identified those act as natural causes for an urban flood. However, urban floods occur due to deficiencies in drainage systems, land permeabilities, and poor management. Cities lose 10% of economic activities and annually experience over 500 million economic damage due to these floods. Hence, urban floods have to be suitably managed.

For managing the flood, it is necessary to identify the reasons for the flood. For urban floods, the causal reasons are identified as higher CO_2 & GHG emissions, cities erected in flood basins, higher population clustering, disturbing the natural cycles in flood sensitive lands, activities of the poor in the urban population, and political

influences on policies & regulations. As all those are related to land utilisation, hance land management is highlighted as the main activity of urban flood management.

A closer look will indicate that urbanisation has resulted from land modifications. When considering the influence on the runoff, apart from the direct modifications on soil, slope and land cover, land's spatiotemporal patterns such as grow, shrink, and shape changes also increase the flood (Figure 2). Reviewing this situation shows that land modifications, directly and indirectly, increase the damage and occurrence of urban floods. Hence, attention should be paid to present land/infrastructure development practices for reducing the effect on flood generation for sustainable flood management.

B. Role of GIS in Hydro modelling

Managing floodwater is essential for flood management. It utilises hydro models, which are mature to provide

administration holds the decision-making authority on lands and properties of a significant land area of a country. The present work has realised that local level consisting of the day-to-day decision-makers. Then automated HydroGIS tool will assist them make land management decisions as the local administrators are non-technical decision makers. Reviewing the present situation, it developed an illustration to show how local administrators' flood management decision-making process can be assisted by the HydroGIS tools (Figure 3).

5. Conclusion

Urban floods research has peaked and found that poor land management is the direct and foremost reason to flood generation as it increased the runoff. Further studies proved that increased runoff boosts the flashiness and gathering of the population and economic activities increase the urban
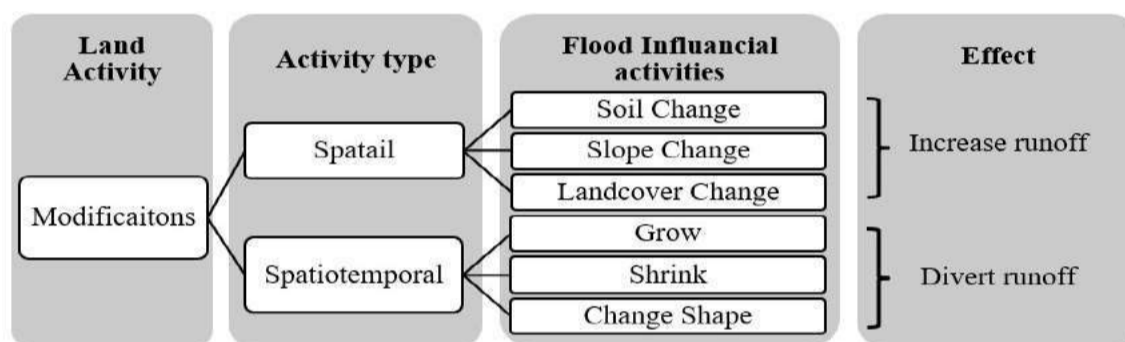

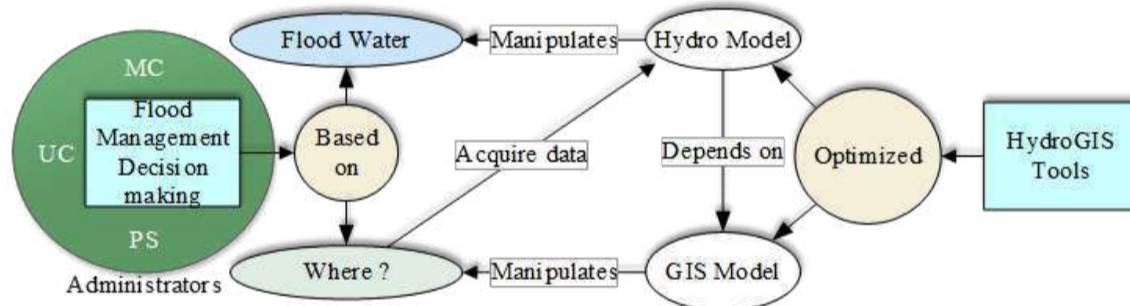Figure 2: Important Land Activities to Urban Flood
Source: Author

Figure 3: The Dependence of the Flood Management and HydroGIS tool
Source: Author

substantial accurate predictions. Hydro models have problems with the model's requirements, but GIS could handle those issues accurately and efficiently (Table 3). Further, analysing ten generic hydrology models it found that GIS can "highly" assist in both the model's process and visualisation requirements (last column of Table 2). The tern HydroGIS was evolved in 1996 and since 2011 it has been researched under computing discipline. Noe the HydroGIS tools known as fully automated or semi-automated hydrology processing tools which use GIS.

C. Role of GIS Tool in Urban Flood Management

Flood management has four different levels: Transboundary, National, Regional, and Local. The local level

flood damages. Hence, land management is a crucial activity in urban flood management.

Since flood is a water phenomenon, flood can be modelled using hydrology. Thousand years of research has made these hydro models well-established and time proven. Nevertheless, the accuracy of the models depends on the spatial information resolution. Such massive spatial data requirement reduces the model performance.

This complex undertaking in the last decades could easily be made with the GIS advancements fuelled with modern technology. Today GIS assists in executing all the core steps in a hydro model. The term "HydroGIS" is used to integrate approaches in GIS-hydro modelling. Since 2012, the term

"HydroGIS tool" has described the automated Hydro model in the GIS environment.

As water management is based on land, land management has different levels with the political administration. In most countries, the smallest management unit is the Municipal/urban/rural council, and they are being powered by land authority. Then the local authority is entrusted to accurately implement any water decision taken from the top authorities and grant under commands with accurate decisions for sustainable flood management. Since non-technical decision-makers in the local authorities make these decisions, the HydroGIS tools become a vital tool for quick decision-making.

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Table 2: GIS Assistance in the Hydrological Model Processes

Research	Hydrological model Processes steps identified		GIS assistance		Average	
			Processing	Visualising	Processing	Visualising
(Sivapalan & Blöschl, 2015, p. 28)	Normative socio-hydrologic model steps (Top-down sequence) • Future Society • Predictive climate • Runoff • Inundations • Failure Probabilities	Explorative socio-hydrologic model steps (Bottom-up sequence) • Possible Society • Possible climate • Runoff • Inundations in context • Failure Probabilities • People	• L • VL • VH • VL • H • N/A	• H • H • N/A • VH • L • N/A	M	H
(Singh, 2018)	Data collection and processing, Concepts and theories, Integration with allied sciences, Computational and analysis tools, Models, and model results		• VH	• VH	VH	VH
(Flamig et al., 2020)	• Input steps (temperature / precipitation / evapotranspiration /discharge) • Model steps (Freeze/melt, water balance, routing,		• H • VH • H	• L • H • VH	H	H
(USDA, 1986)	• Data capture (Tc) • Hydrograph development • Reservoir calculation		• M • N/A • L	• N/A • N/A • N/A	M	N/A
(McCuen, 1989)	Precipitation, Interception, Surface storage and runoff, Infiltration, Interflow, Percolation, Baseflow, Groundwater Storage, Channel Processes		H	M	H	M
(Dawson et al., 2008)	• Develop hydro model through catchment rainfall • Model runoff through urban runoff modelling • Develop depth-damage curves and flood depths • Assess flood depth		• M • M • N/A • M	• N/A • N/A • N/A • N/A	M	N/A
(Wang et al., 2018)	• Accurate DEM develop by revision the DEM, maps, and DSM • Accurate Extraction of flood information through Remote sensing • Flood modelling using the above data and hydro model		• VH • VH • H	• VH • VH • M	VH	H
(Feng et al., 2020)	• Generate Water depth by hydro model • Generate GIS data layers • Classification using the above two • Run flood prediction model using hydro data and above information • Develop flood hazard map		• VL • VH • L • H • H	• N/A • VH • VL • L • VH	M	M
(Maidment, 1996)	• Study design • Terrain Analysis • Land surface: Describing layers • Subsurface: Hydrogeologic works • Hydrologic data: Interpolating data onto grids. • Soil water balance • Water flow computing • Constituent transport: Sediment computing • Water utilisation: Locating reservoirs etc. • Presentation of results		• VL • VH • H • H • H • M • H • M • H • H	• L • H • H • H • H • H • H • H • H • VH	H	H

				H	M
(Guo, Guan. and Yu, 2020)	• Data gathering • Urban Flood Modelling • Net rainfall and runoff simulation • Drainage network and 2D surface runoff	• VH • L • M • H	• H • L • M • H		
Average				**H**	**H**

* VH = The core steps of the process are carried out   H = Core steps of the process are assisted
    (5)   M   = General steps are carried out (3)   (4)   L = General steps are assisted (2)
    VL = Optional works are assisted (1)   N = No assistance (0)
                                                      N/A = Not applicable or not required by the model

Table 3: Problems with Hydro models

Hydro Model	Requirement	Problem	GIS Capability
Distributed model	Need location-specific data, but land and varying over the spatial context	High resolution of data A large amount of data Excessive process power	Optimises the computer power to manipulate a large amount of spatial data
Lumped models	Summations and averages of the spatially distributed data	Accuracy drastically reduces with the area size Averages and summations result in an unrealistic spatial picture	Tools and techniques in the GIS provide more accurate spatial averages and summations
Both models	Trial and error process for calibration, verification, and accuracy Better visualisation	Time consumption for re-run the processes Results are more numerical and need additional effort to make maps and develop visual means	Process sequences can be automated Sophisticated visualisation and those can be customised easily

Factors Affecting User Acceptance of Mobile Banking Applications in Sri Lanka

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Abstract*: In Sri Lanka, numerous banks are beginning to provide financial services via mobile. However, there is a limited number of studies examining the factors affecting user acceptance of m-banking applications. The purpose of this research is to find the problems in existing m-banking applications in Sri Lanka, gather factors affecting the user acceptance of M- banking applications, and collect suggestions from the users on mobile banking applications in Sri Lanka. The researchers are surveyed by using a google form which includes fifteen questions. The sample size of this research is seventy-five. According to the results of the survey, there are various issues in existing mobile- banking applications such as complex user interface, annoying security processes such as complicated steps to follow once the password is forgotten, application not functioning well, slow, language problems, connection problems, the application is being stuck and issues in taking screenshots. So when building a mobile application the banks should consider these problems to make sure the users can use the mobile banking application accurately and efficiently. It is very important to gather suggestions from users, As stated in the results of the survey, the responders have suggested that when building a mobile- banking application there should be some features such as an understandable and simple interface with simple icons, voice commands, and voice explanation with enabling a way that explains the features of the banking application, using simple language with different language options, personalization, enabling notification facility, user-friendliness, simplicity, and enabling authentic security with simple steps and enabling Chabot. The researcher has concluded that when creating a mobile-banking application the simplicity of the interface, using simple language with different language options, and good security with simple steps to follow are the most important factors.*

Keywords: *Mobile, Banking, Technology, Application*

1. Introduction

New technology has now taken a prominent place in many industries. The banking industry is one of the most needed industries in the world as there are many services offered through banks such as trade services, utility bill payments, safety deposits, loans and advances, international banking services, and convenient banking services. When it comes to the banking industry information system and information technology plays a key role, because banks need a lot of information and technology to manage the banking process accurately and effectively. With the rapid development of technology, banks provide mobile banking and internet banking services to customers. Although according to the research paper [1]there are only 20.7 million people in Sri Lanka, the number of mobile phones in use is 22.1 million, especially the youth who have used mobile devices very rapidly. Thus Banks developed m- banking services. Further, m – banking has been introduced to the banks to give more effective and efficient service to the customer to do their banking work without visiting the bank physically. The mobile bank application differs from one bank to another in the services, and interface of m- banking and also with the services and with features that they provide. Users have different ideas about different banking applications. So this research is about the user acceptance of the mobile-banking application. There are a lot of banks in Sri Lanka as NSB, People's bank, commercial bank, BOC, Sampath bank, and a lot more. These banks all provide m-banking facilities to the customers. There are a lot of facts that change the user acceptance of m-banking applications. Thus to do this research it is very important to take information from mobile banking application users, from taking feedback from users the researcher can analyze the factors affecting user acceptance of the m-banking application, problems face while using mobile banking application, and gather suggestions from the user to consider when creating a mobile banking application. The finding of this research will help make a good mobile banking application, to take the information the researcher uses a survey with fifteen questions. By identifying how people use m-banking applications, problems in mobile applications, how mobile applications help people's work, and what things that need to be improved in m-banking the banks can use these data and can build a mobile banking application by solving the problems of the exciting application because of this covid-19 people are afraid to come physically to the bank, and the banks also face a lot of risk because of the pandemic situation, mobile banking application is a very good solution for that also. So by taking the details of this research the banks can build a good m-banking application with the feedback of the users.

Objective: Finding the problems in exciting m-banking applications and Gathering factors affecting the user acceptance of M-banking application

2. Literature Review

Perhaps (Ali, Gallivan, and Sangari, 2019)Banks move into capitalization with the new technology and provide good customer service, because of this new technology banks can provide a good service without any problem by eliminating geographical limitations and time limitations. In this research, the researchers have study about the factors that affect the adaptation of m-banking applications. So to take the information the researchers distributed a questionnaire to 247 users of Sampath bank in the Ampara district and 189 were identified as m-banking users so the researcher gather data about how to perceive usefulness, Perceived ease to use, cost, trust, and perceived risk, these factors have an analyst and the R squared value been 0.61 that means 63%. The result of the questionary shows that 74% use m-banking applications, 18% of customers are not using an m-banking application and 8% hope to use m-banking in near future. So the researchers have identified that when building an m- banking application it should not only have English, it should also have the Sinhala Language according to that, all people are not good in English, and also the researchers have identified that the connection between banks and mobile services providers should be increased. According to this research, the hypothesis accepts the perceived usefulness Perceived ease to use, cost and trust has a major factor in the adaptation of m- banking applications, and perceived risk is not taken as a major factor for the adaptation of m- banking applications in Ampara district

(Ayoobkhan, 2018)According to this research, it mentions that with the development of technology and mobile devices people used mobile to do their banking work, with the Covid-19 pandemic people prefer to avoid others and prefer to keep their distance from others. This research has been done to find factors affecting the adoption of mobile banking among customers in north Gujarat. The researchers have collected data from reading papers and questionnaires. So the researchers have to find that ease of use, internet connection quality, perceived usefulness, and self-efficiency are the factors that affect the users of north Gujarat to use m-banking. Also, the researchers have identified that during the covid-19 pandemic the usage of m-banking has increased.

(George Karma, Balal Ibrahim and Hafiez Ali Hasaballah, 2014)So the researchers have collected data by consulting fifty rich bankers which have registered in U.S FDIC. The researchers have used the iTunes website to identify information about exiting apps for the banks. The researcher mentioned that the information from these research papers can be used by banks and bank managers to identify user needs. There are some limitations and delimitations in this research as these researchers have only taken data from three years, second one is that iTunes provides customers rating only for the current year and as

a delimitation, the researchers have mentioned that the confined data from the iPhone apps and Apps Store for experiment control purpose. In this research, there are also four hypotheses as; H1: mobile banking applications will have better user ratings as they progress in the future, H2: The number of features in a mobile app will be positively related to better rating, and H3: The number of exiting rating of a mobile app will be related to better ratings and H4: The file size of a mobile app will be related to better ratings. so when it's come to the results, the result of hypothesis one is supported, the result of the second hypothesis is not supported, the third hypothesis result was supported, and finally, the fourth hypothesis result is not supported, and also this research found that there is an improvement in mobile banking application start rating is 2012 and 2018.

(Hanudin, Ricardo and Mohd Zulkifli, 2012)This research is done to find the factor that influences mobile banking adaptation in the Kurunegala district. This research has mentioned that there is no study done by telling them how to design an m-banking application, by considering that gap the researchers have to do this research by taking diffusion of innovation as a baseline theory, so to gather data, the researchers have done a questionnaire by choosing 40 customers from four commercial banks in Kurunegala district. There are four objectives in this research the relationship between perceived usefulness and adoption of mobile banking technology, the relationship between social influences and adoption of mobile banking technology, the relationship between perceived risk and adoption of mobile banking technology, and the relationship between perceived risk and adoption of mobile banking technology. The researchers also have illustrated a framework based on the literature review. So the researcher has found that usefulness, perceived risk, and compatibility have a significant value or a significant impact on adapting m-banking and social influence has no significant impact on adapting m-banking

(Islam and Hossain, 2015)This research has been done to identify factors affecting sustainable intention to use mobile banking services. There are three aims of this research to identify perception factors that affect current mobile banking customers' continued use of technology, explain the self-services dimension that affects customer's behavior intention, and be able to recommend the banking industry. The researcher has collected data from 688 exiting by online questionnaire. So this research used SPSS and AMOS to analyze the data. According to the result the researcher has mentioned that there is a positive relationship between self-service technology qualities, perception, and sustainable intention to use mobile banking applications.

This(Kiri, 2020) research has been done to identify the user acceptance of m-banking in Indonesian. So the researcher

has used the Technology Acceptance Model as an approach. So the researcher has taken 205 participants and collected data from them by giving them a questionnaire concerning two banks, so the result shows that there should be more promotions about the usefulness, security, and risk of mobile - banking in Indonesian banks.

(Naruetharadhol *et al.*, 2021)The main aim of this research is to find the factors that influence customer intention to use a mobile application, so for collecting data they used a web-based survey, and the researcher distributed it among 348 people who used m-banking applications. There were two hypotheses. The study is based on two models as technology Acceptance model and the mobile service quality model and the structural equation model is used to analyze the data. So according to the result, shows that there is a positive effect on perceived ease of use, perceived usefulness, and mobile service quality.

(Puriwat and Tripopsakul, 2017)This research identifies the factors that affect the intention of using m-banking in Malaysia. it used the technology acceptance model to identify the factors. TAM includes perceived credibility, perceived self-efficiency, and normative pressure. The result shows that perceived usefulness, perceived ease of use, perceived credibility, and perceived self-efficiency as string determinates, and normative pressure is a weak determinant when it's come to the user intention of using m-banking applications. Moreover, it has been mentioned that perceived case of use and behavioral intention has a significant value when it's come to the intention of users to use m-banking.

(Ravichandran *et al.*, 2016)This research was done to study the factors that affect the user acceptance of m-banking applications in Bangladesh. So in this research, demographic, attitudinal, and behavioral characteristics of the users of the mobile-banking application have been examined. The survey was distributed among 292 people in different banking networks. The research has asked about the ease of use, Infrastructure facility, self-control, social influence, perceived risk, perceived usefulness, and customer service. So this study has mentioned that four factors highly influence Bangladesh's infrastructural facilities, self-control, perceived risk, and social influence, and other factors such as ease of use have less influence.

(Yovita and Ari, 2018)This research is identify the factors affecting the mobile banking adaptation of bank users in Sudan. So the researcher has used the Technology Acceptance Model to analyze the data, which are perceived usefulness, perceives trust, perceived ease of use, and perceived risk. So the researchers have collected data from 181 customers in Sudan. The result shows that perceived trust, perceived ease of use, and perceived risk have a strong influence when it's come to adapting m-banking

applications and perceived usefulness has no significant value for adapting m-banking applications.

3. Methodology

Nowadays most people used bank applications to do their banking work. So the researcher surveyed to collect qualitative information about the users. The survey includes fifteen questions. The questions have been created to gather information about the user's ideas on mobile banking applications, problems that the users have faced while using mobile banking applications, services that they used through mobile banking applications, and suggestions of the users. This research aims to get a clear idea of users' acceptance of them-banking applications. The sample size of this research is seventy-five and the researcher has sent the survey through WhatsApp.

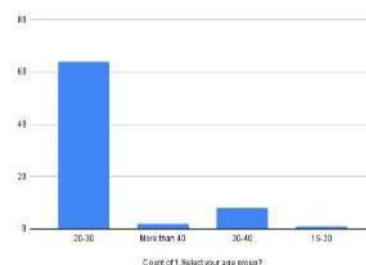## 4. Results and Discussion

1. Age of the responses

Fig .1.Age Group of the Responders

According to figure 1, the researcher can see that the majority of the respondents are between the ages of 20-30.

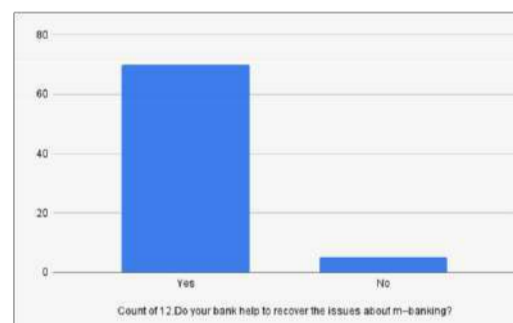2. Are the responses used on their cell phone for financial transactions

Figure .2.Cell phone usage for financial transaction

The above figure shows that most of the responders have used their cell phones for financial and banking transactions and some responders are not using their cell phones for any financial transactions.
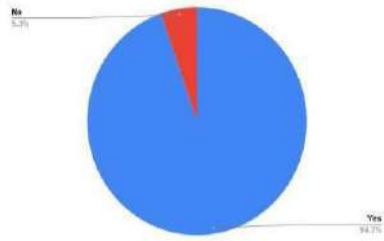
3. Usage of m-banking application

Figure. 3. Usage of m- banking application

Figure 3, shows that 94.7% of responders have used the mobile banking application and 5.3% of the responders are not using M-banking applications, so the researcher can conclude that majority of respondents are using m-banking applications for their banking purposes

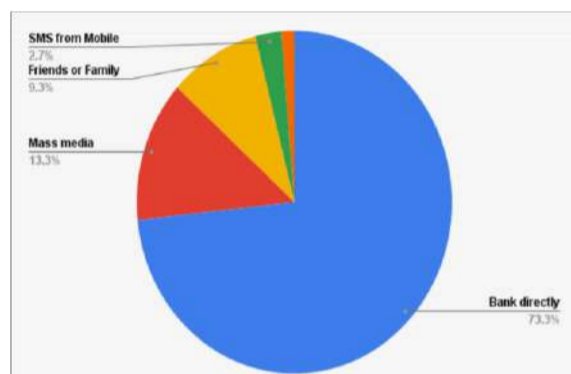4. The way the m-banking users know about them-banking application

Figure.4.Method of hearing about the m-banking application

According to the answers, it shows that 73.3% of responders have heard from banks directly, 13.3% of users have heard from the mass media, 9.3% of users have heard from friends and family, and 2.7% of users. So the majority of the responses have heard about the application is bank directly. It shows that banks have interest to promote mobile banking applications

5. Are banking encouraged to use them-banking application
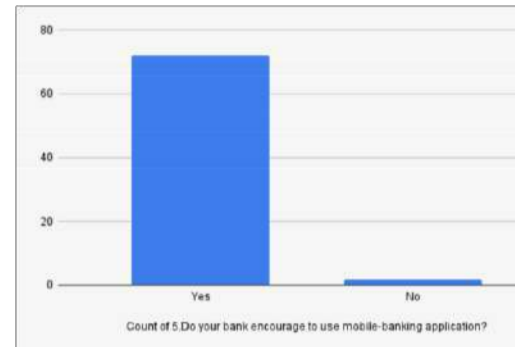
Figure.5.Envolemnt of bank

Figure 5, shows that the majority of users say that banking is encouraged to use mobile banking applications, so banks need to encourage the users to use m-banking, otherwise, users are afraid to use m-banking.

6. Most used service by using m-banking
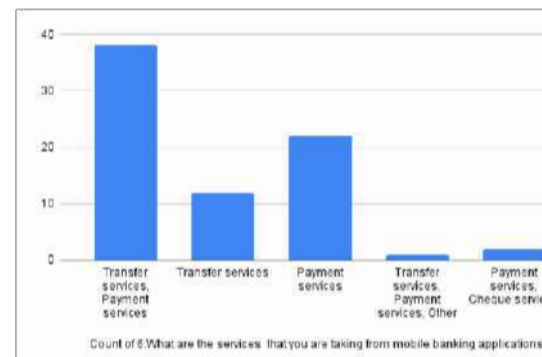
Figure.6.Services of m-banking

This chart shows that transfer services and payments services are the most used services through the mobile banking application.

7. How often the customers use m-banking

Figure.7.How often the customers use m-banking

According to the above figure, it says that 52% of responders are using the mobile banking application weekly, 20% of responders are using m-banking daily, 18.7% of responders used m-banking applications monthly, and 9.3% of responders are used m-banking applications occasionally. So the majority of the users are using mobile banking applications weekly.

8. Knowledge about the m-banking application
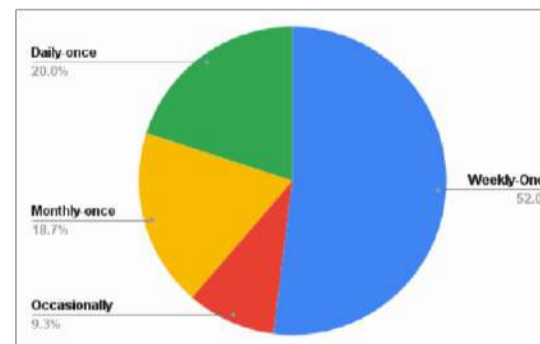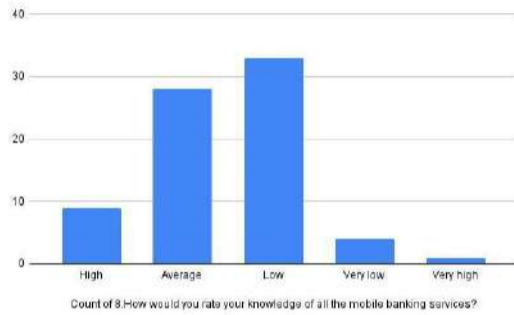

Figure.8..Knowledge about the m-banking application

The above Figure shows that majority of the responders have low knowledge about m-banking. So there should be a proper process to teach the customer about the mobile banking application.

9. Are the m-banking expensive or cheap
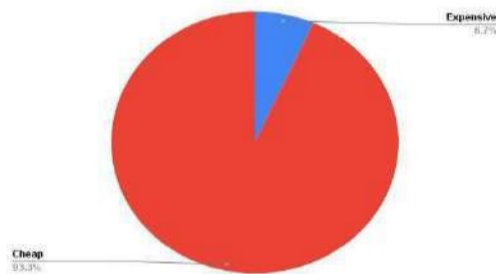
Figure.9.Are m-banking expensive or cheap

So according to the responses, the figure shows that 93.3% of responders are telling that m-banking is cheaper and 6.7%of responders are telling that m-banking is expensive.

10. Have the responses face any problems while using mobile banking
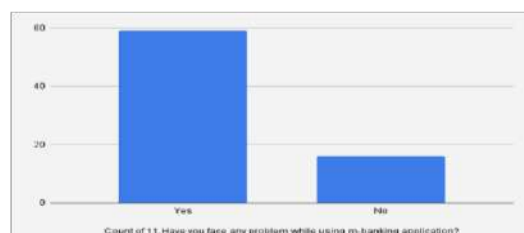
Figure.10.problem using m-banking application

Figure 10, shows that the majority of responders have faced any problem or problems while using the mobile banking application, so these problems should be solved

11. Are the banks helping to recover the problem?
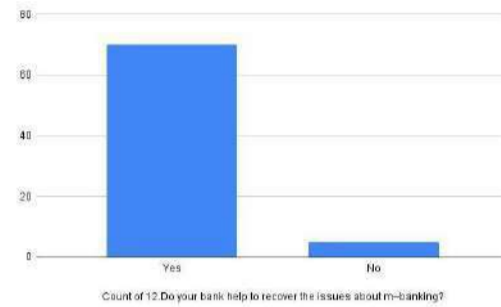
Figure.11.Support from the bank

So according to the results, it can see that most of the responders telling that their bank helped to recover the problems in the m-banking application

12. Problems that users faced when using m-banking applications
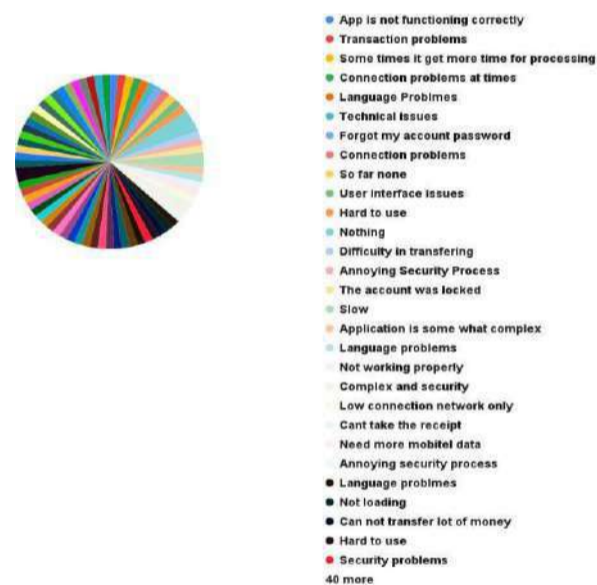
Figure.12.Problems of m-banking applications

According to the above figure, responders have different problems when using m-banking applications. Problems such as annoying security process, the application not functioning well, slow, language problems, network connection problems, hard to use, complex steps to follow once a password is forgotten, cannot take a screenshot of the payment details, the application gets stuck, security problems and cannot understand the interface clearly. The

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majority of the responses have the problem of a complex interface.

13. Features that need to apply when creating an m-banking application
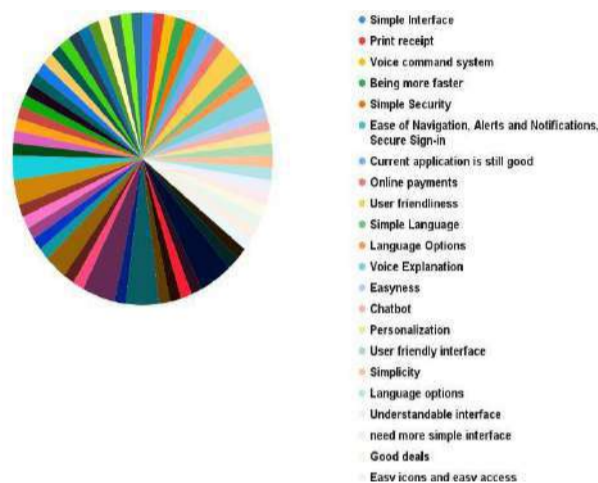
Figure.13. Suggest features for mobile banking application

According to figure 13, There are so many suggestions from responders to consider when creating m-banking applications such as: putting an understandable interface, enabling voice explanation, enabling language options, personalization, putting simple process, enabling voice command, providing transactions via other banking accounts free, using simple words in the application, using simple language in the application, enabling online fund transfers, user-friendliness, simplicity, need a more simple interface and good security are the responders' suggestions when creating an m-banking application. The majority of the responses indicate simple interface and language options as features needed for adding to mobile banking applications

14. Prefer the method to do banking work
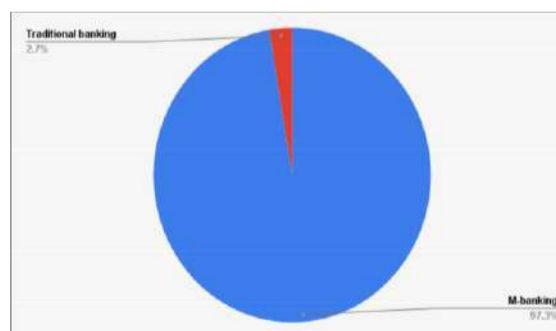
Figure.14.Preference for traditional banking and m-banking

The figure shows that 97.3% of users are telling that they prefer m-banking and 2.7% of users are telling that they prefer traditional banking, according that the majority prefer to use m-banking applications and very less amount of responders prefer traditional banking.

15. Problems occur when using traditional banking

According to the responders, traditional banking is wasting time, having to travel long distances, a large number of forms to fill, slow, need more paperwork and there are crowded the bank. The majority of responders mention that traditional banking is time-wasting.

The answers to these fifteen questions have supplied a lot of information about the mobile banking application and its users

5. Conclusion

The research objectives were to find the problems in exciting m-banking applications, Gather factors affecting the user acceptance of M-banking applications, and gather user suggestions for developing an m-banking application. Most of the results are from the age group of 20-30. The majority of the responses get known about m-banking applications from the bank directly, used m-banking weekly and their knowledge of m-banking applications is very low. According to the survey result, the responders have faced some problems when using m-banking applications such as annoying security process, the application not functioning well, slow, language problems, network connection problems, hard to use, complex steps to follow once the password is forgotten, application getting stuck, cannot take a screenshot of the payments and cannot understand the interface clearly. So these problems should be solved otherwise the users may feel uncomfortable using mobile banking applications. When building a mobile application responders suggest some features such as putting an understandable interface to the mobile banking application, enabling the voice command method, and enabling the voice explanation method to the application, so the user can easily process the banking processes and there should be a language option in the mobile banking application, So when building a mobile-banking application the organization should consider these factors as putting a simple interface with simple words so the user can understand the application well. Having a language selecting option is also very important when creating an m-banking application because in Sri Lanka there are a lot of people who only know the Sinhala and Tamil languages and who cannot understand English properly, it will be more efficient if the mobile bank application includes different languages, personalization is also very important when creating an m-banking application, enabling all the services that provide physically also value the mobile-banking applications more, user-friendliness and good security also take an important place when creating an m-banking application according to the responders. Transfer and payment

services are the most used service of the responders so when building m-banking applications these services should be improved. Factors that affect user acceptance are security, ease of use, language differentiation, and other services such as loan facilities. When creating an m-banking application the banks should concern about the above problems and also consider the suggestion of users that will help the users and banks to provide a good service to the customers accurately and efficiently.

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The Potential of One-Shot Learning for Drug Discovery – A Review

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Abstract: *Compounds with specific chemical properties for treating diseases are sought through drug discovery. The search for drugs can be made more efficient, less expensive, and less time-consuming by incorporating automation. New approaches and technologies in drug discovery have grown dramatically over the past few decades. "One-shot" learning is the best hope for the widespread adoption of machine learning in all industries. In this work, we show how one-shot learning can reduce the amount of data required to make meaningful predictions in drug discovery applications. With Few-Shot Learning (also referred to as One-Shot Learning), models can be trained to learn the desired goal with less data, like humans. The study's objectives are to explore the most prominent ways to identify and forecast drug discovery, potential applications, and several remaining challenges. Chemical structures can be represented using some structural descriptors, a similarity measure is used to compare them, and a strategy can be used to predict the activity of a query compound in this manner. This review will serve as an impetus for future experiments that seek to validate the use of one-shot learning in the chemical sciences.*

Keywords: *One-Shot Learning, Few-Shot Learning, Drug Discovery, Machine Learning*

1. Introduction

For the purpose of developing drug candidates, various properties of compounds, including efficacy, pharmacokinetics, and safety, must be simultaneously optimized in order to make small-molecule drug discovery a difficult multidimensional problem. In the traditional way of drug development, scientists test millions of molecules but only a few make it to preclinical or clinical testing. It is long, expensive, and has a high failure rate. There are many ways to reduce the complexity of drug discovery and avoid high costs and time spent bringing medicine to market, such as embracing new automated technologies. For many years, the drug discovery industry has relied on automation. Pharmaceutical companies will be able to make better decisions more quickly thanks to automation in drug discovery. It's no longer enough to use automation only for high-throughput screening. Automated systems in drug discovery have been around for a long time, despite the perception that they are new. They were first used in pharmaceutical companies to conduct high-throughput screening (HTS) experiments. First, automation was implemented in laboratories to help with high-throughput drug development and production. More recent technological advances have made it possible to improve precision, compliance, and reproducibility even further.

The Search for New Drugs Medical research is all about scientists. New developments in automation may help streamline some lab processes and allow scientists to concentrate on their core competencies. In the laboratory, automation increases efficiency, reducing waste, and speeding up the drug discovery process. The world's most brilliant medical minds are working nonstop to discover new treatments and cures for the world's most deadly and perplexing diseases. The ability of automation to perform large volumes of repetitive tasks has revolutionized the laboratory environment, relieving scientists of some of the modern-day pressures and increasing reliability, throughput, and reproducibility.

As a result of pioneering laboratory work over the past few decades, polio has been nearly eradicated and breakthrough drugs have been developed to combat HIV and cancer. The field of machine learning has made several significant advances in recent years that address complex issues. Machine learning and deep learning frameworks require a lot of data in order to have a practical impact on drug discovery. The problem is that there isn't always enough information for every task. Because of this, the need for machine Learning Algorithms that can learn from a smaller number of examples has become more pressing as Machine Learning enters mainstream domains like healthcare. One-shot learning refers to the idea of learning a class of objects from a small amount of data.

It is a challenge to learn new classes with a small training dataset of just one or a few images per category, known as one-shot learning (OSL). In order to distinguish one-shot learning from standard single object and category recognition algorithms, it relies on the transfer of prior knowledge from previously built models. The ability to learn with fewer training examples is made possible by the transfer of knowledge. When a model has been trained using large data sets, it can be used to perform the same task with less training data. This is known as knowledge transfer.

When one-shot learning is used in conjunction with deep learning, metric learning is almost always involved. FSL should generalize if the transferred information is accurate. By predicting the category of each pair of examples separately instead of performing a direct prediction for each object, a separate training set with sufficient examples for each category can be generated. Meta-learning, on the other hand, is used in a variety of ways to overcome the challenge of learning from a limited number of examples. A new

approach is presented in this paper that discusses and demonstrates how one-shot learning can significantly reduce the amount of data needed to make meaningful predictions in drug discovery applications.

2. Literature Review

The paper by Mahdi Rezaei and Mahsa Shahidi describes Zero-shot learning and its applications in autonomous vehicles and COVID-19 diagnosis(Rezaei and Shahidi, 2020). Besides the barrier of a limited annotated data set, they have performed a comprehensive and multi-faceted review of the Zero-Shot/Generalised Zero-shot Learning challenge, its fundamentals, and variants for various scenarios and applications such as COVID-19 diagnosis and autonomous vehicles. There are four space-wise embedding categories for the most recent state-of-the-art methods. In order to solve ZSL, they've analyzed the most popular datasets and their corresponding subsets. It also contributed to the results of some common baselines and elaborated on assessing each group's advantages and disadvantages as well as the ideas behind different areas of solutions to improve each group. Their evaluation shows that data synthesis methods and combinational approaches have the best results, as by synthesizing data, the problem shifts to the classic recognition/diagnosis problem, and by combining other methods, the model utilizes the advantages of each embedding technique.

In the paper "Machine Learning in Drug Discovery: A Review," ML models can perform alternative tools like PPT inhibitors and macrocycles with traditional algorithms if they are trained in a known framework i.e., the compound structure. Because of their high success rate in clinical trials, chemical structures and QSAR models derived from pharmaceutical data can also be included in deep learning models(Dara *et al.*, 2022). Artificial Intelligence has taken a significant step forward in computer-aided drug development, according to the authors. The use of machine learning techniques in drug discovery has run into some problems. Because multiple deep neural networks are trained effectively on a large volume of data, the performance of deep learning methods can directly influence data mining innovation. The primary goal is to address the issue of automatic transfer learning. Another problem with neural networks is that many parameters can be tweaked during training, but some theoretical and practical frameworks are inaccessible.

Introducing the task of low data learning for drug discovery, "Low Data Drug Discovery with One-Shot Learning" provides an architecture for learning such models. Using this architecture, they have shown that it outperforms other methods for learning with low data sets. They found that on the Tox21 and SIDER datasets, one-shot learning methods outperform simpler machine learning baselines in terms of performance(Altae-Tran *et al.*, 2017). These findings are of particular interest to the SIDER collection, which is comprised of high-level phenotypic side effects observations. According to them, their work is not simply

an adaptation of one-shot learning to molecular data sets but rather an entirely new approach. Previous one-shot algorithms18 attempted to perform object recognition for new classes of images using only a small number of examples from each class as a learning tool.

"One-shot Learning Approach for Unknown Malware Classification" takes advantage of these advancements to introduce a novel method to help malware analysis identify and categorize malicious software in less than 10 known samples(Tran, Sato, and Kubo, 2018). Using natural language processing and a Memory Augmented Neural Network (MANN) for a one-shot learning task has been demonstrated in this paper. Even with only one recognized sample, classification accuracy is quite good.

"Wheat Disease Recognition through One-shot Learning Using Fields Images" proposes a wheat disease recognition network based on one-shot learning that not only requires a small number of images for training but can also accommodate new categories because it can be trained even on a few images of a new type(Mukhtar *et al.*, 2021). By providing a few images of diseased plants, farmers can quickly re-train their network and begin testing again. As a feature extractor, they've used the MobileNetv3 network, which is extremely fast and accurate.

In Nikhil Thakurdesai's paper, one-shot learning is used in another way. Different face recognition algorithms have been proposed, but one stands out in the case of a small dataset: one-shot learning.' To learn something in "one shot," all you need is one piece of training. In order to address this issue, a solution is presented in this paper(Thakurdesai, Raut, and Tripathi, 2018). Large datasets are required by neural networks to achieve high accuracy. Using only one training sample, this paper proposes a solution to the problem of low face recognition accuracy by reducing the number of training samples needed to one.

3. One-Shot Learning Approach

It is a classification task where one or a few examples are used to classify many new examples in the future. One-shot learning is Classification tasks that are carried out using past data by one-shot learning. Many machine learning applications can be found in situations where data is scarce, and this technology can help. There's a striking resemblance between the way humans learn and recognize new concepts without having previously seen them. In one-shot learning, we only have a single example of each class. Now the task is to classify any test image to a class using that constraint. Multiple training examples are used in the form of few-shot learning, a more flexible version of one-shot learning. An approach to model building that relies on the transfer of knowledge from other models to use a training set of only a few examples was coined in 2006 by Fei-Fei Li et al. in the field of computer vision as the term "one-shot learning." When a model has been trained using large data sets, it can be used to perform the same task with less training data. This is known as knowledge transfer. The

challenge of learning new classes from a small training dataset of one or a few images per category is known as "few-shot learning." FSL should generalize if the transferred information is accurate. Meta-learning, on the other hand, is used in a variety of ways to overcome the challenge of learning from a limited number of examples. Overfitting is a common problem, so the main challenge is to improve generalization.

4. Methodology-One-ShotLearningFor Drug Discovery

The Search for New Drugs Medical research is all about scientists. To develop drug candidates, various properties of compounds, including efficacy, pharmacokinetics, and safety, must be simultaneously optimized to make small-molecule drug discovery a difficult multidimensional problem. The world's most brilliant medical minds are working nonstop to discover new treatments and cures for the world's most deadly and perplexing diseases. Large-scale testing is now possible thanks to automation. It has also lowered the cost of electricity and other equipment. Compounds with specific chemical properties for the treatment of diseases are sought out through drug discovery. The approach used in this search has become increasingly important in computer science recently, as machine learning techniques have exploded in popularity since they became more accessible. To speed up the research process and lower the costs and risks associated with clinical trials, this review identifies relevant literature on one-shot learning techniques for the discovery of new drugs.
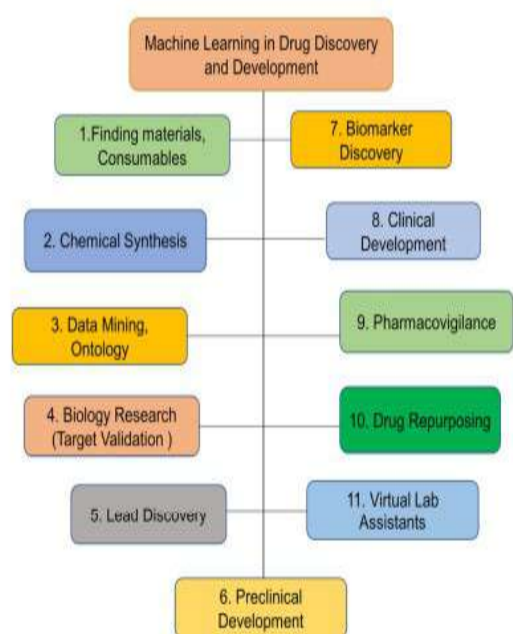

Figure 1. Various fields in drug discovery by using Machine Learning
Source: Author

Large amounts of manually annotated data ("labeled data") are frequently required by machine learning models. That means that they need constant human intervention to retrain the underlying model with more data. One of the most pressing issues in machine learning is how a model can learn if only a few samples are available instead of using too much data. Deep learning and machine learning are typically more accurate when more data is used. Computational drug discovery relies heavily on the use of similarity searches. Chemical structures can be represented using some favourite descriptors, a similarity measure is used to compare them, and a strategy can be used to predict the activity of a query compound in this manner.

As in the case of one-shot learning, this procedure can be used even if only one or a few examples of each of the activity categories are known. Both methods have their advantages and disadvantages, but there is a major difference between the two. The primary difference is that the descriptors, the similarity metric, and the comparison method all have to be learned from scratch in the case of one-shot learning. Medicinal chemists have grown confident in the similarity search over the years because of its universality, efficiency, conceptual simplicity, and high level of trust. Cons: It's a heuristic approach that's rigid, which leads to suboptimal results. But one-shot learning's greatest advantage is its ability to learn from examples while also finding the best solutions for specific datasets. A few drawbacks of this approach should be considered as well. These include using black-box approaches that are difficult to interpret and therefore not well understood by most pharmaceutical scientists. Another drawback is that the criteria used to select auxiliary data for knowledge transfer are unclear because this approach relies on poorly understood black-box approaches that aren't well understood by pharmaceutical scientists. As a result, we can see that one-shot learning has a good chance of becoming a viable option for drug discovery with further exploration and development.
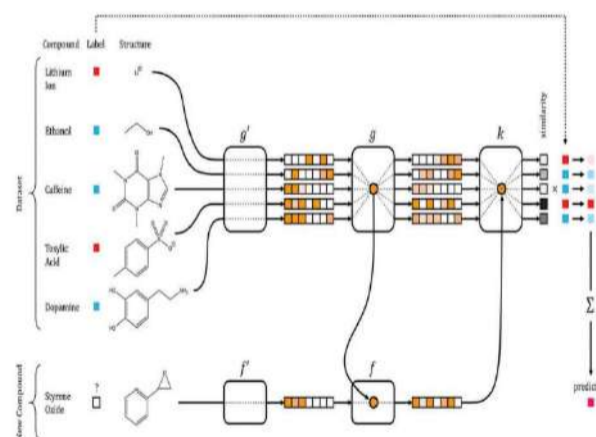
Figure 2. The IterRefLSTM (Iterative Refinement Long Short- Term Memory) architecture for drug discovery one-shot learning. The neural network's augmented memory is preloaded with feature vectors representing a labeled reference set of chemical compounds (left). An attention mechanism weighs the most similar compounds more heavily than the test compound's feature vector (bottom) (right). The activity class of the test compound can be predicted using the weighted combination of all labels.

Source:
https://www.tandfonline.com/doi/full/10.1080/17460441.
2019.1
593368#:~:text=Several%20benchmark%20studies%20re
ported
%20in,adverse%20effects%20of%20marked%20
drugs.

i. LIMITATIONS OF ONE-SHOT LEARNING

One-shot learning has some drawbacks, despite its allure. Only one Siamese neural network is capable of solving a given problem. Facial recognition neural networks can't be used for tasks like determining if two photos are of the same dog or cat because they're designed for one-shot learning. Other variations affect the neural networks' sensitivity. For example, if the person in one of the images is wearing a hat, scarf, or glasses, but the person in the other image isn't, the accuracy can suffer significantly. The process of discovering new drugs is extremely complex. There is a risk in using one-shot learning techniques in drug discovery because accuracy is so critical in the medical arena.

5. Discussion

Low data learning for drug discovery is described in this paper, along with an architecture for creating such models. The pharmaceutical industry uses AI technology, including machine learning algorithms and deep learning techniques, on a daily basis. Images and omics data have been the source of many problems for ML techniques in the pharmaceutical and health care industries. The fact that one-shot learning can do well in these predictions is a strong indication that these methods could offer strong performance on small biological data sets, given the amount of uncertainty in these predictions. Only through experimentation can one-shot learning in chemistry be proven to be effective.

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Touchless Palmprint Recognition System using Image Processing

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Abstract : *A biometric system is a system that uses biometric data and mathematical algorithms to recognize a certain feature of an individual. In recent years from various biometric identifiers palmprint has been widely used for identifying people. Palmprint is popular nowadays because of its ridges is big compared to the fingerprint. The use of palmprints has reawakened attention due to recent developments in image capabilities on mobile and wearable consumer devices. Specially in this COVID19 situation and also because of privacy and sanitation it is good and more secure to use touchless system rather than a touch-based system. So, a touchless system prevents society from using fake biometrics. In this paper we design and develop a touchless palmprint recognition system to verify people. In proposed system people can verify themselves more accurately and quickly. This system contains two modules such as Enrollment module and Identification module. And Enrollment module is mainly used to store the palmprint details in the database and from the Identification module system verify people. Here we use Gabor filter as the feature extraction tool and used IITD touchless palmprint dataset.*

Keywords: *Palm Print Recognition, Touchless Palm Print Recognition Systems, Feature extraction, Gabor Filter.*

1. Introduction

The field of biometrics is used to analyze the uniqueness of biological and physiological characteristics with the aim of confirming a person's identity. To accomplish this requirement, there are a lot of biometrics systems have been designed and used in all over the world.

A biometric system is a system that recognize a certain characteristic of an individual using mathematical algorithms and biometric data. These systems offer numerous numbers of benefits. Since biometric data is non-transferable, unforgettable, distinct, and unique compared to other traditional identification methods such as pin numbers and passwords. Due to these advantages, biometric authentication methods can be trusted. Generally, we use most common biometric identifiers such as fingerprints, facial, voice, iris, and palm to recognize and confirm person's identity. Among them, palmprint can be identified as a special biometric type when compare with others due to its promising features.

2. The Research Problem and Solutions

In these days traditional identification techniques are not suitable for identification systems as they are less secure. Users no longer receive the user security or protection they require from passwords. The capacity of a machine to crack passwords increases with the power of computers. Moreover, Cybercriminals might also purchase them to use in fraud and unlawful access with every new cyberattack. Traditional authentication techniques like usernames and passwords, pin numbers, tokens cannot be trusted to confirm user identification because accounts can be quickly accessed with leaked information. This poses a serious traditional security threat to the information.

When comparing with traditional authentication systems, biometric techniques give more benefits. They are quicker and more practical for users, reduces the friction caused by conventional security techniques and, they have strong authentication since their characteristics re distinct. Also because of public demand for privacy and sanitation everyone prefer touchless system compared to a touch-based one. Specially during this covid19 situation people avoid the touch-based systems. There are many advantages of using touchless approaches such as, easy maintenance, low resolution imaging, stable structural feature, low-cost hardware, fast feature extraction, high verification accuracy, easy availability, and high user acceptability. In public safety, banking, and other systems, biometric applications have played an essential role.

Accordingly, palmprint is discriminative and robust, which can be easily verify with compared to other hand features (2). In addition, it has a higher anti- spoofing potential than faces or fingerprints that helps to leave traces on a variety of smooth surfaces. Not only that but also, palmprint contains more information than fingerprints as it has many lines. Mainly, there are three types of lines that are named as principal lines, wrinkles, and ridges. The significance of these lines is that these lines are used to extract features of the palmprint.

In this proposed system we used raspberry pi camera module for image capturing and Gabor filter as the feature extraction tool. And for the database it used MySQL. The experiment carried out using Python. For the developing part it used IIT Delhi Touchless Palm- print Dataset.

This article does a deep dive into the developed Touchless Palmprint Recognition System. It has been divided into several sections that will touch in order, the problem addressed by the system, the proposed solution, the existing systems related to touchless palmprint recognition system along with their pros and cons, the design of the Touchless Palmprint Recognition System, methodology and details on the system in action. The article will wrap up with its conclusions and references.

3. Related Works

Satya Bhushan Verma and Saravanan Chandran [1] proposed a Touchless Region based Palmprint Verification System. The palmprint was verified using a Gabor filter and a local binary pattern in this paper. In this paper they used IITD and CASIA touchless palmprint databases. In this study, the Chi-square distance, Manhattan distance, and Bhattacharyya distance are used to calculate the distance between two histograms during the verification phase. The proposed approach for verification was evaluated using FAR (False Acceptance Rate), FRR (False Rejection Rate), TSR (Total Success Rate), and EER (Equal Error Rate). The proposed model had the highest FAR=1.5 percent, FRR=1.5 percent, TSR=99.25 percent, and EER=0.75 percent for the Rotation Invariant Uniform Local Binary Pattern using Bhattacharyya distance parameter, and the highest FAR=1.5 percent, FRR=2.5 percent, TSR=99.00 percent, and EER=1.00 percent for the Rotation Invariant Uniform Local Binary Pattern at

Chi-squash. Palmprint verification takes 0.88 seconds using the proposed method.

Haryati Jaafar, Salwani Ibrahim, and Dzati Athiar Ramli [2] proposed a Robust and Fast Computation Touchless Palm Print Recognition System Using LHEAT and the IFkNCN Classifier. This work focuses on low-quality palm print picture. The image was segmented during preprocessing to get the ROI. Hand tracking and ROI segmentation are terms used to describe this technique. After that, the image was enhanced using the LHEAT approach. To extract the picture data and minimize the dimensionality of the input data, the principle analysis component (PCA) was used. The classification accuracy was greater than 90% with the LHEAT methodology. Furthermore, the CA attained by the IFkNCN approach was increased to more than 90% for both clean and corrupted pictures, with a processing time of less than 120 milliseconds.

Wai Kin Kong, David Zhang and Wenxin Li [3] proposed a Palmprint Feature Extraction Using 2-D Gabor Filters. This study treats the palmprint as a texture and uses texture-based feature extraction algorithms to authenticate palmprints. To retrieve textural information, a 2-D Gabor filter is utilized, and the hamming distance of two palmprint pictures is compared. The ROI was extracted using a coordinate system based on the limits of fingers. They also used a 2-D Gabor filter to extract textured features and match distances. After the testing, they discovered that the 11th filter is the most accurate of the 12 filters. Their matching approach involves translation and rotational invariance, which is combined with the effects of preprocessing and rotated preprocessed images.

Nageshkumar.M, Mahesh.PK and M.N. Shanmukha Swamy [4] proposed a multimodal biometric system by the combination of face image and palmprint. This work introduces a novel method based on PCA called canonical form, which improves performance and accuracy for both features (face & palmprint). Euclidean distance was used to obtain the matching score for each trait. The metaclassifier and multimodal levels of the multimodal system have been built. Multiple algorithms are integrated to produce superior results at the multi-classifier level. Individual systems were originally created and tested for FAR, FRR, and accuracy in an experimental setting. The system's

overall accuracy is over 97 percent, with FAR and FRR of 2.4 percent and 0.8 percent, respectively.

Slobodan Ribaric and Marija Marcetic [5] proposed an approach based on Gabor filter for color palmprint images. A bank of Gabor filters extracts the features from the palmprint region, which is represented by three principal spectral components: R, G, and B. A generalized Hamming distance is used to match palmprints. For fusion of color palmprint photos, they get a recognition accuracy of 98.710.37, while the best identification accuracy for a grey palmprint image is 98.31 0.52 for the same database.

A. H. M. Al-Helali, W. A. Mahmmoud, and H. A. Ali [6] proposed a fast personal palmprint authentication based on 3-D multi wavelet transformation. The use of a 3-D discrete multiwavelet Transform as a feature extractor and a probabilistic artificial neural network (PNN) as a classifier is presented in this paper as an innovative and quick palmprint authentication technique. They tested and evaluated their proposed method upon 240 palmprint images. The proposed technique performed well. It concurrently achieved a greater real acceptance rate and a lower false acceptance rate.

Saravanan Chandran and Satya Bhushan Verm [7] proposed a Touchless Palmprint Verification using Shock Filter, SIFT, I-RANSAC, and LPD. The IITD palmprint database and the CASIA palmprint database are used in the experiment. The SIFT matching score is obtained after refining and compared to the threshold value. If the matching score above the threshold, the palmprints are regarded to be from the same hand; otherwise, they are from distinct hands. The findings of the experiment reveal that the proposed unique method matches the palmprint with 100% accuracy and in a short amount of time.

M. I. Ahmad, M. Z. Ilyas, R. Ngadiran, Mohd Nazrin, and S. N. Yaakob [8] proposed Palmprint recognition using local and global features. The proposed approach is put to the test with the PolyU dataset. This research proposes a palmprint identification system that combines data from global and local feature extraction techniques. In terms of recognition and verification rates, the experimental findings employing PolyU datasets show improved performance. The proposed method has the best performance, with 97 percent recognition rates and 98 percent verification rates.

Dewi Yanti Liliana and Eries Tri Utaminingsih [9] proposed a biometric palm recognition system combining palm print and hand geometry. First, they applied preprocessing then they extracted two features one for palmprint and another one for hand geometry. After extracting features from hand geometry and palmprint, they matched with the database by test feature. They tested the model with 100 samples by using three methods, using a) palmprint, b) hand geometry and c) combination of palmprint and the hand geometry. They achieved higher accuracy rate 89% by the combination of palmprint and the hand geometry compared to others.

Hao Li, Zhenhua Guo, Shouyu Ma and Nan Luo [10] proposed A New Touchless Palmprint Location Method Based on Contour Centroid. The distance between corner points and contour centroid was used in this paper to suggest a new method for finding the centre block of a palmprint image. This technology is made up of an unique touchless palmprint image collection device and an efficient palmprint locating algorithm. A ring source, two CCD cameras (one for near infrared, the other for visible), a frame grabber, and an A/D (analogue-to-digital) converter were incorporated in the touchless palmprint capturing device. The proposed approach may operate at a 96.6 percent genuine acceptance rate, while the false acceptance rate is 3.5747 percent. And it can tolerate the rotation of palmprint image in plane surface.

Paper no. & Year	System name	Palmprint dataset	Feature extraction	Used tools (other)	Features
01 (2017)	"Touchless Region based Palmprint Verification	IITD and CASIA	• Gabor filter and Local binary pattern	• Bhattacharyya distance • Chi-square	• Fast identification

02 (2015)	"Robust and Fast Computation Touchless Palm Print Recognition System Using LHEAT and the IFkNCN Classifier"	Database contains 2400 color images	• Principle analysis component (PCA)	• Canny edge detection algorithm • LHEAT • IFkNCN classifier	• Robust and Fast Computation • The device is cost-effective • Does not require expensive hardware • Much faster compared with previous techniques, such as LHE and LAT. • Works well in noisy environments.
03 (2003)	"Palmprint Feature Extraction Using 2-D Gabor Filters"	a palmprint database contains 4,647 palmprint images	• 2-D Gabor filter	• hamming distance	• Used low-resolution palmprint images
04 (2009)	"Multimodal biometric system by the combination of face image and palmprint"	a data set including 720 pairs	• canonical form based on PCA	• Euclidean distance	• Better recognition performance • Accuracy of more than 98%.
05 (2012)	"Approach based on Gabor filter for color palmprint images"	a database consisting of 4647 palmprint images	• Gabor filters	• Fusion at the matching-score level • Hamming distance	• achieved a slightly better performance in comparison with the grey-scale system.
06 (2012)	"Fast personal palmprint authentication based on 3-D multi wavelet transformation"	dataset of 240 samples of palmprint data	• 3-D discrete multiwavelet Transform	• probabilistic artificial neural network (PNN)	• Has a novel and fast palmprint • authentication technique • A higher genuine acceptance rate and a lower false acceptance rate simultaneously
07 (2015)	"Touchless Palmprint Verification using Shock Filter, SIFT, I-RANSAC, and LPD"	IITD and CASIA	• SIFT	• Shock filter • RANSAC algorithm • LPD algorithm	• shows that the proposed novel method matches the palmprint 100% accuracy and in short time.
08 (2014)	"Palmprint recognition using local and global features"	PolyU	• discrete cosine transform(DCT) • LDA	• Fusion at the matching-score level •	• able to increase discrimination power and preserve low frequency coefficients
09 (2012)	"Biometric palm recognition system combining palm print and hand geometry"	dataset of 200 samples of palmprint data	• block-based line detection	• Dynamic Time Warping (DTW)	• highest accuracy rate compared to both of single feature palm print method or single feature hand geometry method.
10 (2011)	"New Touchless Palmprint Location Method Based on Contour Centroid"	database containing palmprint images from 116 different people	• corner point extraction		• Achieve a faster and more stable location on palmprint image.

					• Can tolerate the rotation of palmprint image in plane surface.

(Table 1: summary of techniques and tools that used in reviewed papers)

4. System Design and Methodology
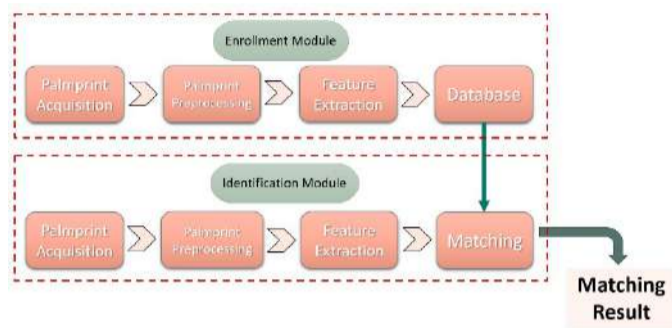
(Figure 1: Design of the system)

The design of the novel Touchless Palmprint Recognition System mainly contains two modules such as the enrollment module and the identification module. In the enrollment module there are four sub modules as image capturing module, preprocessing module, feature extraction module and storing module or the database. Similarly, in the identification module, there are four sub modules as image capturing module, preprocessing module, feature extraction module and palmprint matching module. A brief description of each module is given below.

a. Enrollment Module

The main task of this enrollment module is, taking the palmprint images of the users and save them in a database. Here first, we capture the palmprint image and preprocess the image. Then extract features by using a filter and store the feature extracted palmprint image in the database. There are 4 main sub modules in Enrollment Module.

    i.   Palmprint Capturing module
    ii.   Image preprocessing module
    iii. Feature extracting module
    iv.   Storing module

b. Identification Module

The main task of this Identification module is, find if there is a matching palmprint image in the database to the image just captured. Here first, we capture the

palmprint image and preprocess the image. Then extract features of the preprocessed image and compare it with the palmprint images in the database already. Then if it found a similar image, it displays the person is verified and if it didn't find a similar image, it displays the person is not verified. There are 4 main sub modules in Identification module.

    a) Palmprint Capturing module
    b) Image preprocessing module
    c) Feature extracting module
    d) Image comparing/matching module

a) Palmprint capture

In this touchless palmprint recognition system, it designed a model to capture the palmprint. Here we take the image from a Raspberry Pi camera module.

(Figure 2: Original Palmprint Image)

b) Image Preprocess

In this Image preprocessing step, we mainly obtain the part (sub palmprint image) that is unique in palmprint. Then we eliminate the variation happens to the image due to rotation and translation. Here we crop the image and keep the part that is including principal lines, wrinkles, minutiae points, singular points, and texture. And convert the image into grayscale. Then increase the contrast and the sharpness of the image. This proposed palmprint recognition system used python for this image preprocessing part. The main purpose of

this preprocessing step is to extract the certain region form the palm-print which includes principal lines, ridges, and wrinkles.
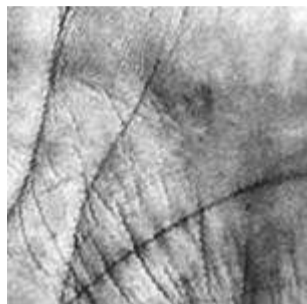
(Figure 3: Preprocessed Palmprint Image)

c) Feature Extraction

After passing the data through preprocessing step, it needs to extract the features that is unique in the palmprint image. Here it used Gabor filter as the feature extraction technique. Gabor-based approach is widely used for the feature extraction in biometric applications, such as iris, face, fingerprint and palmprint recognition. It is a powerful tool in the fields of computer vision and pattern recognition.

It has several benefits, including rotation, translation, and lighting, all of which are enhanced by capturing the device and palm structure. Because of the larger number of degrees of freedom, the Gabor filter allows for more flexibility in the determination of function form.

$$G(x, y, \theta, u, \sigma) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}} e^{2\pi i(ux\cos\theta + uy\sin\theta)}$$

$i = \sqrt{-1}$

u = the frequency of the sinusoidal wave

θ = controls the orientation of the function
σ = the standard deviation of the Gaussian envelope.
The σ and u are dependent on the size of the filter with

$\sigma * u$ = const.

d) Database

After the system extract features, the feature extracted image stored in a database. Here the system use MySQL for store the palmprint images. During the development of this research the IIT Delhi Touchless Palm-print Dataset was used, and this database mainly

consists of the hand images collected from the students and staff at IIT Delhi, India.

e) Palmprint matching

In here we measure the similarity using a matching score of palm print and hand geometry features between test data and the data stored at the training database. The matching score is obtained using Dynamic Time Wrapping (DTW) distance. The higher matching score, the more similar the data. In advance, features must be normalized and scaled prior to the DTW process. The recognition will undergo the same process; each feature vector in the database is compared with the test data and the highest matching score is recognized as the user's feature.

5. Conclusion and Furtherwork

This paper presents a touchless palmprint recognition system using image processing. Although there are several systems for person recognition, this proposed system will be able to increase the accuracy, privacy, and sanitation for everyone because this is a biometric authentication method, and it is touchless.

Further this system has to test and evaluate in to ensure the development of touchless palm print system is more applicable in real application, experiment in various types of noises needs to be extracted before the feature extraction.

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Knowledge Based Expert System for Defect Identification and Rectification in Engine and Steering Control Systems of Fast Attack Crafts

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Abstract:Cognitive systems deal with symbolic manipulations on knowledge and it's stored as rules, theories etc. State-of-the-art fault detection methods are equipment and domain specific and non-comprehensive. However, possessing domain knowledge and human reasoning can be applied for fault detection by having a thorough understanding of the associated system and its surroundings. This study introduces a complete semantic framework for fault detection and diagnostics (FDD) in system simulation and control of an indigenously designed engine and steering control system for Fast Attack Crafts (FAC) by the Sri Lanka Navy. The suggested technique includes the construction of knowledge base for FDD purposes using rules and offers increased functionality of such systems using inference-based reasoning to extract information about operational anomalies. Hence, an Expert System (ES) has been designed as a solution for defect identification and rectification (DIDR) challenge for the indigenously designed Naval Propulsion and Steering Control (NPSC) System onboard FACs.

Keywords: Defect Identification and Defect Rectification, Expert System, knowledge base, inference-engine, user interface

1. Introduction

With the development of early cognitive systems over the years, ES have gained widespread recognition in a variety of domains like technical, medical and social fields. An ES is a knowledge-based system that simulates expert cognition in order to solve important issues in a certain subject of expertise. Hence, an ES can be utilized for domain specific problem solving in areas such as analysis, classification & interpretation, diagnosis & debugging, monitoring & control, designing, planning & prediction etc. All these applications have been practically applied with ES solutions.

It is a computer software that imitates a human expert in a given subject by using explicitly expressed knowledge and computational inference techniques. As a result, ESs typically consist of three key components: a knowledge base, an inference engine and an user interface. The knowledge base contains a set of facts, procedures, knowledge etc. The inference engine which has the reasoning technique is the power of an ES. Several problem solving strategies are used in such intelligent reasoning like search, forward and backward chaining, conflict resolution, uncertainty handling. User Interface provides access to developers or users to handle inputs and outputs to the ES through an interface such as Natural Language Processing (NLP), chatbots, asking questions via voice and text etc.

In the domain of DIDR of a mechanical system, several diagnoses in technological processes have been created. Model-based approaches, knowledge-based approaches, qualitative simulation-based approaches, neural network- based approaches and traditional multivariate statistical techniques are among these strategies.

The research has been focused on DIDR of engine and steering control system designed as NPSC which has been installed onboard FACs. An ES has been designed in this study for DIDR of the NPSC system and has to be accessed when a fault alarm arises in the system. A user friendly interface has been designed for easy interaction with the system.

A. Problem Statement

The NPSC system which is indigenously designed and developed by Sri Lanka Navy is an advanced engine and steering control system based on programmable logic controllers (PLC). A marine grade control system is vulnerable to get defected out at sea. While a FAC is patrolling out at sea, there is less possibility for the seamen to identify the technical defects with their general

knowledge. Hence, the craft has to come alongside a pier for technical expertise assistance by keeping the primary task at sea non-addressed. This has been identified as a major issue since task of a FAC corporates with security, operational and finance matters directly. Proper FDD implementation can enable proactive DIDR before they have a major negative impact on the operating system's safety, security or efficiency. Hence, an in house solution was found to address the matter by introducing a system which acts as an ES for DIDR.

B. Objectives and Scope

This study has focused on the use of expert knowledge in the domain of defect identification and rectification of engine and steering control systems for an Expert System. The applied ES is proposed for the indigenously designed NPSC system. Whenever a defect occurs in the system, a fault alarm is indicated on the designed Human Machine Interface (HMI). Hence system operates on specific/narrow areas only. Officer in Command (OIC) of a FAC out at sea will be the client. Hence, in any defect regarding NPSC system, he can get consultation from the ES for defect identification and rectification.

The ES is designed to ask various questions according to the error reading in alarm format and comes to the precise conclusion based on forward chaining. Processing incomplete information has been achieved by asking questions at the forward chaining process. Further, this system provides alternative solutions to identify the defects when forward chaining questioning happens. Further this provides certainty factor of a final conclusion but it is required to train the system with several clients with their point of view on defect identification and experience to get the best certainty factor. This FDD system also recommends further actions for rectification process rather giving the exact answer to the root cause of the defect and it gives reasons for final conclusions as well.

2. Literature Review

ES development for fault diagnosis in maritime environment has being most popular due to the requirement of fault detection and diagnosis while at sea is critical and essential. Automatic fault diagnosis is an artificial intelligent problem solving application and a variety of intelligent algorithms have been applied in this area. Among these methods, rule based ES is one of the most widely used methods.

An ES for power system fault diagnosis in a ship has been developed by Chao Liang in 2020 where Frame structure is used to describe the power system connections between various parts of the ship in knowledge presentation. ES uses production rules to describe the specific fault and combine the ideal of fuzzy inference to dealing with the uncertainty in fault diagnosis at the same time.

Designing of an ES for diagnostics and estimation of steam turbine components has been completed with conditional probability to diagnostics and state estimation of steam turbine technological subsystems' components. The ES is based on Bayes' theorem and permits one to troubleshoot the equipment components, using expert experience, when there is a lack of baseline information on the indicators of turbine operation.

Fault diagnosis for marine engines was developed by Xiaojian in 2017 known as belief rule-based (BRB) system where each subsystem has its distinctive outputs and uses the evidential reasoning approach for inference. This novel modeling approach can be applied to identify fault modes that may co-exist. In essence, the group of BRB subsystems is used to model the nonlinear relationships between the fault features and the fault modes in marine diesel engines.

Xin-Yu Shao, in 2009 has developed ship engine room automation novel system named ES for Aided Conceptual Design of Ship's Engine Room Automation (ESACD). With the support of the constructed Ship Data Warehouse System, two core subsystems Configuration Selection Assistant (CSA) and Design Scheme Decision Assistant (DSDA) are included in ESACD. A promising approach integrating Fuzzy c-means algorithm (FCM) and Rough Sets Theory (RST) to extract configuration rules from the stored data is adopted in CSA.

An ES for ship automation has been developed by Zbigniew Kowalski in 2001. The shell ES Exsys Developer was used to create the ES and which is characterized by a rule-oriented representation of knowledge, backward and forward chaining inference methods, various confidence modes to handle uncertain reasoning including fuzzy logic and possibility of co- operation with other software and databases. The databases were made using the MS Access software also known as a Knowledge Based.

Many online and offline ES development tools such as Exsys, Exsys logo, Corvid, Corvid logo, Exsys RuleBook, Exsys RuleBook logos , ES Builder, What I Need to Know (WINK) etc have been designed by worldwide companies.

3. Expert System Structure

The standard ES architecture has been used in designing the ES as depicted in figure 1. The domain expert is the Electrical Engineer who has the technical knowledge of the NPSC System. Expert knowledge is thus acquired in the knowledge base. The reasoning techniques are configured in the inference engine. Exsys Corvid runs the inference engine at the backend and provides a local host window as the User Interface to be accessed by the client.
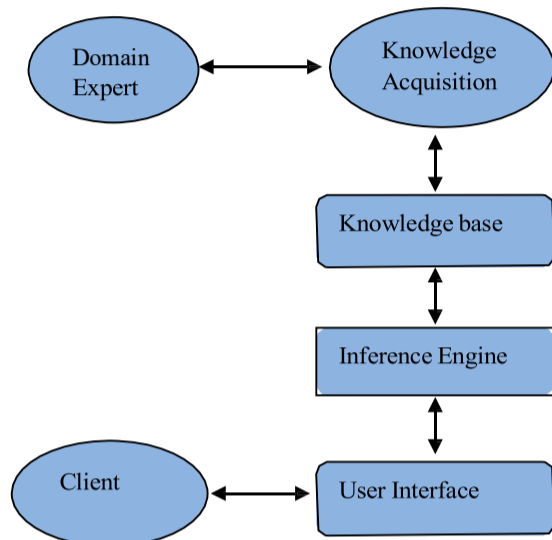

Figure 1. Used ES Archetecture

4. Implementation

The designed ES has been developed using Exsys Corvid tool. It is an offline executable program which is ideal for utilizing out at sea where internet is absent. The designed ES is capable of handling under mentioned 14 Nos. of fault alarms which are identified as probable to occur out at sea in the engine and steering control systems of a FAC.

- No cooling water flow alarm
- Engine Lub oil temperature high alarm
- Low level in cooling water tank alarm
- Engine cooling water temperature high alarm / shutdown
- Gear box Lub oil temperature high alarm
- Gear box Lub oil pressure low alarm / shutdown
- Engine Lub oil pressure low alarm / shutdown
- Engine exhaust temperature high alarm
- Engine charge air temperature high alarm
- Engine sea water pressure low alarm
- Low level in engine Lub oil alarm
- Engine over speed shutdown
- Crank case over pressure shutdown alarm
- Bucket/nozzle system malfunction

The stand alone system is carried in the wheel house of the FAC and can be accessed at any time. Nearly fifty root causes have been identified for the above mentioned alarm types. The knowledge base includes the domain knowledge of an expert to clarify the root causes that have guided for the fault occurred. The client or the end user need to enter the fault alarm/s at the user interface of the ES. Then. all possible root causes are forwarded to the client through forward chaining process. Finally, client can interact with the ES and follow the recommendations given by it to rectify the defect by the boat's crew itself out at sea. In addition, the recommendations include alternative solutions to try by the repair team.

5. Performance Evaluation

It is common for a defect to occur out at rough seas and battle environment. But, to determine a certainty factor by the system itself or manually, many iterations of defect identification and rectification has to be undertaken by the ES. Since, defects do not occur in such frequency, defects are created intentionally and ES is followed in order to assign a certainty factor to the specific alarm rectification solution provided by it. Same methodology was carried out for all defects by several clients.

Table 2. Certainity Factor Table

Defect No	Defect Alarm	Defect root cause	Certainty Factor
1	No cooling water flow alarm	Water Cooling Flow Level not adequate	95
2		Ground Fault/ Wire Break	80
3		Flow Switch Defective	89
4		Defect in the PLC System	84
5	Bucket/ nozzle system malfunction	Wire break in feedback potentiometer	95
6		Steering solenoids defective	99
7		Power Supply Module defective	96
8		Feedback potentiometer defective	84
9		Solenoid Driver defective	85
10		PLC System Defective	80
11		Wire break/ ground fault	97

Certainty factors were assigned manually based on the probability of correct solutions recommended by the ES for any given fault alarm and samples are tabulated in Table 1. Certasininty factors have been obtained for 49 Nos. of defect root cuases which may give defects under aforementioned defects.Thus calculated certainty factors are summarized in Figure

2 for easy visualization. It can be observed that the calculated certainty factor for all root causes lie above 80%. Hence, the performance of the ES can be assessed and concluded as successful.
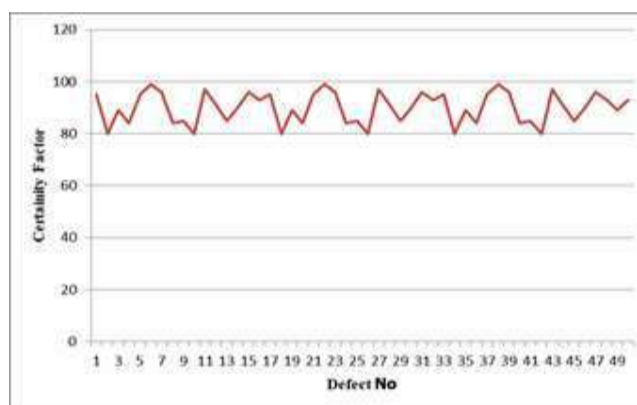

Figure 2. Certainity Factor Summary

6. Conclusion

The research paper has been based on creating a Knowledge Based Expert System to determine the defects which are probable to occur out at sea in the indigenously designed Naval Propulsion and Steering Control System of FACs. An offline ES tool named —Exsys Corvid‖ has been used to design the standalone system. Pre-identified probable defects in the knowledge base have been used to reason the root causes by the ES. Since, the end user is not a technically expert personal and no provision is available out at sea for physical Defect Identification and Rectification, the designed ES is a timely solution to minimize life threat and cost.

The outcome of the designed ES has been evaluated with the aid of the Certainty Factor and concluded to be satisfied.

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Acknowledgment

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Integrating Artificial Cognitive Systems in Smart Agriculture

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Abstract: Agriculture is one of the most crucial sectors in the world since the livelihood of both the human beings and animals depend on the attempts taken to upheave the agricultural sector. The concept of smart agriculture has been a research arena that has been broadly researched and discussed by researchers around the world and is being applied in almost all the aspects of the agricultural sector, namely, soil, weed, cultivation, and crop management. Yet, all the systems deployed in smart agriculture still try to automate a narrow action thus increasing the efficiency. The integration of cognition into the agricultural process by utilizing the new trends in artificial intelligence can result in major improvements in the concept of smart agriculture. Nevertheless, artificial cognition and embodiment of cognition to the agricultural process have not been achieved to a greater extent. A comprehensive literature review has been carried out in this research and this study aims on overviewing the role of artificial cognition in smart agriculture. The agricultural aspects namely, soil, crops, and plant diseases have been overviewed with the contemporary artificial systems along with the challenges to the concepts of smart agriculture and artificial cognition in order to add knowledge for future research.

Keywords: Artificial Intelligence, Artificial Cognition, Cognitive architectures, Smart agriculture

1. Introduction

Cognitive computing is one of the core areas of Artificial Intelligence (AI) and researchers in this field obtain inspiration from human cognition for their research work (Wang, 2018). Cognitive computing is the imitation of human thought process as a model in computer (Dharmaraj & Vijayanand, 2018). The term cognition primarily derives from the notion of human cognition where human cognition refers to the ability of humans to use the five senses, vision, sound, smell, tongue, and touch and respond accordingly. In addition, the ability of humans for self-reliance, figuring things out for independent, adaptive and anticipatory action are referred as cognition (Vernon, 2014). At present, the advancements in Artificial Intelligence has upheaved the aspects of embedding cognition into systems. Although

there exists advanced tools, technologies, and theories in the field of computer science and artificial intelligence, there is a gap in fully embedding cognition in to these artefacts (Wang & Xia, 2021).

Artificial cognition is the process of embedding human level of cognition in to either hardware or software systems to achieve human level capabilities. The field of artificial cognitive systems is contributed by various other fields such as cognitive neuroscience, and development psychology etc. Nevertheless, embedding cognition into systems is not an easy task due to the fact that human cognition is not yet fully understandable and there are still no known techniques to fully embed cognition into systems. Furthermore, human level of thinking is not achievable yet via a system although the human knowledge can be embedded to a greater extent. Human cognition tasks are therefore, evident to be not fully achievable up to now and however, if it can be achieved that will be one of the greatest achievement in the field of artificial intelligence. Furthermore, psychological science and AI keep on improving each other as the studies related to these two fields invent and uncover new theories (Ruhela, 2019). Artificial cognition has headed its way towards many industries and agriculture is one such domain that is being investigated.

As all living organisms solely depend on food for their existence, enhancing the agricultural sector with the use of AI and related cognitive systems is of greater importance to increase the efficiency and productivity. Agriculture will continue to be a significant source of revenue for many countries, and smart agriculture will transform the agricultural landscape in the coming years. Throughout the history of humankind, significant advances have been made to boost agricultural productivity with fewer resources and labour demands. In the past, agriculture was based on the experience of the farmers who involved in the agricultural activities and the digital era has made the agricultural aspects also to be enhanced with the integration of AI (Awasthi, 2020).

Among the advantages of cognitive ergonomics approaches, improved work efficiency, reduced human

error, and strengthening the knowledge available in how humans process information are much prominent (Vasconez et al., 2019). Therefore, the agricultural sector is also obtaining a greater advantage by the approach of cognitive ergonomics.

Robots that are involved in agricultural sector are typically either autonomous or semi-autonomous and the use of robots with some cognitive capabilities are noted in several stages of the agricultural process (Vasconez et al., 2019). The field of smart agriculture is yet to explore the integration of fully autonomous cognitive systems that will enhance the productivity and efficiency in all the aspects of agriculture.

This study deeply investigates on the role of agricultural systems that have been developed in relation to the agriculture and that have brought out the term smart agriculture. The rest of the paper is laid as follows. The section 2 deals with the methodology of the research conducted while section 3 briefly discusses different aspects in agriculture that utilize smart techniques. The section 4 discusses the challenges to the concept of smart agriculture while section 5 includes few scenarios where cognition can be embedded artificially to the smart agricultural systems. Final section concludes the research findings.

2. Methodology

In order to be precise in terms of the objective of this research, the authors have identified the motives to conduct the research as research questions for this study, which are stated below.

RQ1: How the agriculture has been affected by the concept of smart agriculture?

RQ2: What are the challenges faced by smart agricultural paradigm?

RQ3: How artificial cognitive systems can be integrated into smart agriculture?

Searching for literature was done from the IEEEXplore and Google Scholar databases. The published work after 2015 were considered as the inclusion criteria of the literature. The selection of the papers to extract data was decided on the applicability and the integration of cognitive abilities into agricultural systems in line with the objective of the paper. Finally, the extracted data were interpreted in the rest of the sections of the paper.

3. Agricultural Aspects

This section briefly overviews on the application of smart systems in soil, weeds, and crop categories with the use of literature that were obtained from the Methodology stated in the section 2 of this paper.

A. Soil

Soil is the crucial ingredient of agricultural operations due to the fact that most agricultural crops are grown in soil hence agriculture and soil are inseparable. Nevertheless, due to the growth in world's population and increased urbanization and industrialization the agricultural land areas are shrinking (Cullu et al., 2019). Crop production need to be improved and soil resources need to be conserved with a thorough understanding of diverse soil types and conditions. Therefore, soil testing is critical in modern agriculture in order to optimize productivity and protect the environment from overuse of fertilizers (Lukowska et al., 2019).

The authors (Lukowska et al., 2019) have researched on the soil sampling and have come up with a six-wheeled soil sampling mobile robot that has proven for the efficiency in productivity in agriculture. The information of soil fertilization has also been a concern of many researchers in the field of smart agriculture. The researchers have proposed an intelligent system that is based on the idea that farmers acquire all the important information about improving soil and agricultural fertilization with the use of Internet of Things (IoT) sensors (Maheswari et al., 2019). A four-wheeled agricultural robot has been implemented by the researchers (Fan et al., 2017) to collect information of both the soil and crop information in open fields that utilizes a touch screen for the generation of the control command and six motors for the mobility of the robot. Nevertheless, the researchers have not specifically stated a procedure for the collection of soil or crop information.

Moreover, soil monitoring systems are capable of responding quickly to adverse circumstances, such as extreme weather or chronic drought, by monitoring soil conditions. An autonomous soil monitoring robot has been implemented by the authors (Piper et al., 2015) that collect data on soil moisture and temperature at some specified points in the field. Nevertheless, the autonomous robot will not act on its own with the collected information of soil, whereas the collected data from the field will be forwarded to the farm manager for investigation.

The attempt by the authors (Isnanto et al., 2020) concerns on controlling the soil condition using the ESP-NOW protocol that works in real time to monitor the humidity of soil as well as the temperature and humidity of the air. This autonomous robot will both monitor the soil condition and act accordingly to water the crop. Furthermore, the protocol that has been utilized in this autonomous robot allows the operation without connecting to Wi-Fi.

The autonomous robot developed by (Martini et al., 2020) is capable of moving to any specific location within the field and water the plants without any human intervention

according to a specified schedule to retain the moisture of the soil in the field. RoSS robot, implemented based on removing human dependency in soil sensing, penetrates the soil to send a sensor probe to detect the moisture level (Bourgeois et al., 2022). Moreover, it is a low cost robot that evaluate the soil health and send it to a cloud server. Further works of this research include, the integration of a GPS, camera and a LIDAR unit.

Autonomous fertilizing is also being considered by researchers in the field of smart agriculture. A robot has been proposed (Arivalagan et al., 2020) to fertilize the soil autonomously and this system is more efficient due to the reason that it can be used in gardens, agricultural, and horticultural fields as well.

B. Crops

Crop production is confronted with enormous difficulties mainly due to reasons such as diseases, low yield, damage from animals and natural disasters etc. Therefore, in order to ensure the security of food and ecosystem, future crops must be designed for sustainable agriculture development by boosting net production while minimizing negative environmental effects. The researchers (Tripicchio et al., 2015) have made use of drones for the purpose of distinguishing between techniques used for ploughing in fields with the use of an RGB-D sensor. Generally, image acquisition in smart agriculture is a crucial task since information gathering in smart agriculture mostly concerns on image data. Analysis and reasoning based on image data is a tedious, time-consuming task in large agricultural farms. The further works of this research includes achieving a high resolution for the designed system with the use of new sensors.

Seed spreading is also an integral part of crop management where the farmer engagement is extensive if the agricultural area is large. The primary goal of automating the seeding process is to make it more efficient and precise than traditional seed sowing methods. Therefore, many researchers have worked on seed spreading robots that upheaves the smart agricultural concept. A seed spreading robot has been designed to perform seeding on a pre-defined fixed distance in the agricultural field (Arthaya et al., 2019). The further works include embedding intelligence to pick weeds in the agricultural field. An Agribot has been designed by (Naik et al., 2016) for the seeding process with the use of precision agriculture concept where each and every crop is treated independently. Furthermore, the researchers have utilized the concept of optimal depth and distance in the approach of seeding task.

The identification of crop rows is an essential task for almost all the activities in the agricultural sector. Both the tasks of crop row identification and navigation between the crop rows have been achieved successfully with the use of

clustering algorithm in a mobile robot (Vachos et al., 2020). Agrobot (Prajith et al., 2020) can be stated as an all-in-one robot that does crop management in agricultural fields. Digging soil, seeding and watering activities are all autonomously done by this robot.

Crop harvesting robots are also gaining much attention where the humans are minimally involved in the process of harvesting in agricultural sector. Small and medium sized low hanging crops have been aimed and a harvesting robot has been implemented with the use of NI RoboRIO controller (Hsia et al., 2020). Nevertheless, since the fields are not even, the image acquisition without the background is a challenge. The robot developed by (Xu et al., 2019) for image acquisition can be remotely configurable. The aim of these researchers is to minimize the challenges that are encountered in traditional image gathering techniques with the use of cloud computing and wireless network technology. The attempt by the researchers (Feng et al., 2015) has concerned on a robot that harvest tomatoes with a higher success rate and prevent the fruits being damaged by integrating a sac with constant air pressure for grasping the fruit.

C. Plant Diseases

Plant diseases pose a serious threat to the agricultural process. As a result, it is critical for farmers to adequately deal with diseases and monitor them using prompt prevention methods. Crop diseases have been generally divided into two categories: abiotic (also known as non-infectious) and biotic (also known as infectious) (Anon, 2022).

A plant health monitoring system with an 83% accuracy level was implemented by (Rizk & Habib, 2018) for early detection of plant health with the acquisition of images from the crop. This system enables early detection of malnutrition conditions and classify the plants as healthy or unhealthy and the system is able to sprinkle pesticides according to classification.

A robot has been developed by the researchers (Murugan et al., 2020) for the purpose of spraying pesticides and this robot can be operated with a mobile phone. This system comprises of three units, namely, input, spray and control processing, and output. Nevertheless, this system is not fully autonomous since the farmer has to manually operate the robot functions of movements, spraying, and stop spraying functions with the use of the mobile interface. The autonomous robot that has been implemented by (Dhumale & Bhaskar, 2021) is capable of acting autonomously for spraying the pesticides and is based on image processing where the plant disease detected by the robot. The work done by (Dharanika et al., 2021) is much similar to the previous work, however the concern is only towards leaf disease detection.

The uniqueness of the work done by researchers (Nooraiyeen, 2020) in leaf disease detection is that the autonomous robot that has been designed is voice controllable and after the detection of the accurate disease by the robot and alerting it to the user, it provides with the measures that can be taken to encounter the identified disease. Another approach taken by researchers in preventing plant diseases in agricultural sector is removing the unwanted part of the plant once the disease is detected. The research work (Rahul & Rajesh, 2020) focuses on the automatic detection of the plant diseases and to cut the stem where the leaves are affected and is with an accuracy of 79%.

It is clearly evident that all the above discussed methods and technologies in smart agriculture have mainly focussed in automating a very specific task. Yet none of those methods and techniques are capable enough of embedding general cognition into any of these systems.

4. Challanges To Smart Agriculture

This section briefly discusses the challenges to the smart agriculture concept and limitations in embedding cognitive aspects in smart agriculture. The developments in Artificial Intelligence has enabled farmers to adopt autonomous farming technology and make use of predictions based on past and current conditions. All these approaches involve many hardware systems that need power and connectivity to function. The challenges to the concept of smart agriculture has been the focus of many researchers (Kassim, 2020) (Ayaz et al., 2019). Based on the reviewed literature, Figure 1 illustrates the challenges to the concept of smart agriculture.
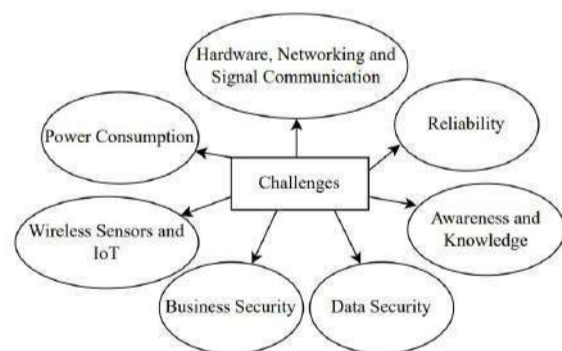

Figure 1. Challenges to Smart Agriculture

When the extent of the farming area is very large, the power consumption is high in autonomous systems. Therefore, the concern is to either reduce the power usage or to improve the battery life. Moreover, hardware aspect has also been challenged since the autonomous systems must deal with harsh environmental situations while performing smart agriculture. Networking aspect has also been challenge since there are many physical obstacles in cultivating fields

where the Internet of Thing (IoT) devices that are embedded in the cognitive system gets interrupted. These IoT devices stream real time data that needs to be analysed for making smarter agricultural decisions. The infrastructure in autonomous systems in agricultural fields are highly complex and also, in rural areas in most countries, the network communications are very slow or not at all present. Reliability and scalability is really essential since the autonomous system must not fail in any situation and must be scalable if the cultivation field is widened. Nevertheless, it is understood that most of the farmers are not aware and familiar with the latest technologies in the aspect of smart agriculture. Data security and business process are also crucial while implementing such systems.

Moreover, none of the present smart agricultural systems are integrated with cognition where these systems can evaluate the current internal and external conditions and reason out, adapt to changing situations and take decision over anticipated situations. Adaption of proper cognitive architectures in smart agriculture is yet a research challenge. In addition to the above, knowledge gap in identifying and modelling of human level cognition is a challenging task that limits embedding of cognition into these smart agricultural systems.

5. Integrating Artificial Cognitive Systems Into Smart Agriculture

Artificial cognitive systems are embedded with the ability of learning, reasoning and anticipation as fundamental capabilities. Thus, these capabilities can be harnessed into smart agriculture for developing cognitively able autonomous systems. Further, farmers will be able to deploy autonomous farming technology and make better predictions of the future, based on current and past conditions, reducing crop diseases and pest invasions, due to the recent surge in Artificial Intelligence. Identifying the correct architecture to integrate cognition is a much researched area at present. A combination of cognitivist and emergent architectures will be a good approach for smart agriculture as it allows the leverage to utilize the inherent and integrated knowledge while accounting for emerging situations.

The real world examples given next, discusses how cognition can be integrated in smart agriculture. In the scenario of soil sample collection what would be if the system has the ability of deciding whether the designated place is the most suitable place for collecting the sample. If the designated place where the sample to be collected is trampled and damaged by wild animals, then that soil could be contaminated with animal waste. By integrating cognition into the system it will be capable of identifying such situations and reason out to avoid such places thereby avoiding taking erroneous decisions. In the sprinkling water scenario if the system is capable of identifying

weather it is about to rain, already rained or the crop does not require water or else the leaves do not look healthy therefore some nutrient needs to be added to the water etc., facilitate cognition in smart agriculture systems. The process of autonomous fertilizing can also be uplifted if the soil fertility can be predicted and fertilize accordingly. Another agricultural process that can be embedded with cognition is the cultivation phase where the robot can be made to identify the relevant places in the agricultural field to cultivate the particular plant types in the seeding process. Spraying pesticides can be stated as an agricultural activity where farmers tend to be more careful, and therefore, the full control has not been given to the agricultural robots yet.

Therefore, it is apparent that artificial cognition concept allows the robots not to work only according to a pre-programmed rules and knowledge yet there needs to be room for learning and improving itself by interacting with the environment. Moreover, once the smart agricultural robots are integrated with cognitive capabilities, less human interaction may be needed since artificial cognitive systems are capable of acting on their own to achieve goals by perceiving their environment, learning from experience, anticipating the need to act and adapting to changing circumstances.

6. Discussion And Conclusion

Through this research, it was identified that the concept of smart agriculture is strongly based on automating the routine steps of agriculture to enhance efficiency and effectiveness. Integration of AI and IoT have further improved and accelerated the adaptation. Yet it was noted that no cognitive abilities are integrated to any of these systems to a significant extent. This was clearly evident based on the literature review done with respect to soil, crops, and plant diseases. To achieve cognition, it is required to integrate the proper cognitive architecture into systems that are deployed in smart agriculture. Hence we propose a hybrid architecture which is a combination of the cognitivist and emergent architectures to integrate cognition into the agricultural systems. Yet this poses a great challenge due to the fact that complete knowledge on how human cognition gained and works is not completely understood yet. This gap is further widened due to limitations in infrastructure and connectivity. Nevertheless, the research in this field will further enhance the cognitive facet of smart agriculture in future.

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Driver Emotion Recognition for Safe Driving: A Comprehensive Survey

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Abstract*: Accidents on roads have been a serious issue for decades in the world. As a solution to this issue, driver emotion recognition has gained much attention where the affective states of the drivers are monitored. In the context of driver emotion recognition, both the physiological and non-physiological signals are utilised in identifying the emotional states of the drivers. Among the approaches taken by researchers in determining the driver emotional states facial emotions, speech emotions, Galvanic Skin Response (GSR), Electrocardiogram (ECG) signals, Electroencephalography (EEG) signals, etc., are much more prominent. Nevertheless, physiological signals are a valuable asset in identifying the emotional states since non- physiological signals such as facial emotion recognition, that is mainly used to detect driver affective states, can be misleading. This study aims to review the literature related to driver emotion recognition that aims on ensuring the safety of road users. Furthermore, the approaches taken by the researchers in the reviewed literature have been briefly discussed, and the challenges to these approaches have been further discussed to enhance the safety of road users and future research in the paradigm of driver emotion recognition.*

Keywords*: Affective Computing, Challenges, Driver Emotion Recognition, Road Safety, Safe Driving*

1. Introduction

Road accidents can be stated as a global challenge faced by almost all the countries in the world. This has resulted in many deaths, fatal injuries, and irreplaceable disabilities to individuals (Gamage et al., 2021). The World Health Organization (WHO) statistics indicate that road injuries are included in the top ten leading causes of death in low-income, lower-middle-income, and upper-middle-income countries (The top 10 causes of death, 2022). Therefore, it is proven that road accidents are a critical issue that must be considered.

Figure 1 depicts the road death statistics of the WHO, in WHO regions. It is apparent that except for two WHO regions with slight reductions in death rate, all the other WHO regions have increased road deaths since the year 2000. Nevertheless, the statistics also show that the global road death rate has been increasing within the past few years. Moreover, it must be stated that not only do the drivers and passengers get affected due to road accidents, but also almost all road users, including pedestrians have to suffer from road accidents.
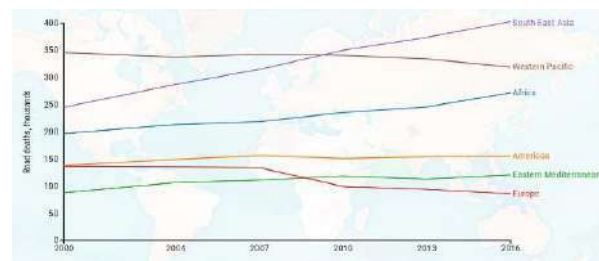

Figure 1. The road death rate in WHO regions
Source: (WHO | Death on the roads, 2022)

The above issue has led to the emergence of the driver emotion recognition paradigm where the emotional states of the drivers ought to be monitored for better road safety and thereby reduce the road accidents that cause due to the affective states of the drivers. Emotions are vital in decision-making and activating behavioural responses in individuals (Kazemitabar, Lajoie and Doleck, 2021). Therefore, the driver emotion recognition approach can be stated as a more appropriate approach for minimising road accidents since drivers are responsible for most road crashes where a slight change in the driver's affective state can cause a severe damage. Affective gaming concepts have also emerged (Kalansooriya, Ganepola and Thalagala, 2020), while incorporating biosignals in virtual reality systems are also noted (Kalansooriya et al., 2016) in the paradigm of affective computing.

Generally, two main approaches to driver emotion recognition exist: physiological and non-physiological signals. Physiological signals include the signals generated within the human body, while non-physiological signals include signals concerned with humans' external behaviour. EEG, ECG, and GSR are some physiological signals, while facial, voice, and gesture emotions fall under the non-physiological signals. This research aims to review the contemporary research in driver emotion recognition along with the challenges faced by the existing approaches and to

add quality knowledge to enhance future research in this paradigm.

The rest of the paper is organised as follows. Section 2 includes the methodology that is followed while conducting this review work. Section 3 presents a critical literature review that discusses the contemporary literature on driver emotion recognition. Section 4 includes the discussion section that presents the challenges to emotion recognition approaches. The final section concludes the conducted research and provides further direction for future research in the field of driver emotion recognition for enhancing road safety.

2. Methodology

The research conducted in this paper focuses on reviewing the published work on driver emotion state recognition for the safety of drivers. The methodology follows the general procedure for conducting a literature review as put forward by the researchers (Templier and Paré, 2015).

A. Formulating the research

The objectives of this study are based on investigating the affective states that are focused on by the researchers as the emotional states that cause the drivers to distract from their normal routine, and the approaches and techniques that researchers in driver emotion detection have utilised in order to ensure the safety on roads. Moreover, challenges to the driver emotion recognition approaches are to be investigated based on the emotion recognition approach being employed.

B. Searching the literature

IEEE Xplore, and Google Scholar databases were used to search the literature.

C. Screening for inclusion

In order to review the literature for this survey, the published work after the year 2015 was concerned to include the contemporary literature in the conducted research.

D. Assessing quality

The literature that matches this study's scope and the objective was identified after the initial screening.

E. Extracting Data

Data relevant to the research objectives were extracted from the chosen literature.

F. Analysing and synthesising data

A summary of the reviewed literature has been formulated by broadly discussing the approach and focused emotional states/affective states where a comparative approach has been undertaken. Furthermore, the challenges faced while

detecting the driver's emotions in real-time while driving has also been discussed.

3. Literature Review

There have been multiple attempts by researchers in the paradigm of driver emotion recognition, and the approaches taken by these researchers fall under the physiological and non-physiological approaches. The focus of the researchers on the emotional states is also varying, and it is observed that some researchers focus on identifying just one emotional state while some researchers concern on identifying multiple emotional states.

Yan et al. (Yan, Wan, Qin and Zhu, 2018) have focused on the Angry emotional state, and three scenarios have been used to arouse the anger of the drivers, and these include frequent waiting for the traffic light, traffic blockage, and the intervention of encompassing vehicles on the road. Furthermore, these scenarios were practised in both the driver simulation environment and on road. The proposed angry driving detection model by these researchers has proven that this model has an accuracy of 85.0% to differentiate angry driving from normal driving. Driving anger that is also referred to as the 'road rage' has been the main concern of the researchers (Wan, Wu, Lin and Ma, 2019) when ensuring the safety of the drivers on roads. For the experimental study, thirty private car drivers on a congested path in Wuhan, China. From the results, the researchers have identified thirteen features that have a significant influence on the anger states of the drivers and these have been collected using multiple sensors concerning three data sets, namely, driver physiology, driving behaviours, and vehicle motions. Researchers (Naqvi et al., 2020) has concerned about driver aggressiveness, and the proposed system has employed facial features for driver emotion recognition, and the classification of emotions has been done as aggressive driving and normal driving. Further, the researchers (Hu, Zhu, Gao and Zheng, 2018) have incorporated biosignals, EEG and ECG in analysing the road rage of the drivers that they identify as a significant feature that influences the young drivers while driving.

Another emotional state that researchers try to address widely is drowsiness which is also termed as fatigue. According to the researchers Jan and Ahn (Jang and Ahn, 2020), driver drowsiness has been a major reason for the large-scale accidents that occur on roads, and facial and eye-blink recognition technologies have been used in the proposed system to detect the drowsiness. Further, a CO_2 sensor chip has also been utilised to ascertain further drowsiness and speech recognition has been used to convert speech to text so that the driver is able to request for the desired music or call someone in order to prevent the driver drowsiness while driving. Another group of researchers have identified that fatigue has been a vital cause of road

accidents. These researchers have proposed a system with EEG signal analysis as the basis in a hypoxia plateau environment (Jing, Liu, Zhang and Guo, 2020).

Sarala et al. (Sarala, Yadav and Ansari, 2018) have worked on differentiating between positive and negative emotional states to enhance the safety of road users. An advanced driver assistance system has been developed by these researchers that work as an adaptive driver voice alert system using deep learning based on the emotions of the drivers. The emotional states of the drivers are determined using facial emotion recognition based on CNN, and Facial Emotion Recognition (FER) 2013 dataset is used in this regard. The voice alerts are produced intensively during the negative emotional states, while a moderate amount of voice alerts are generated in positive emotional states to assist the driver to focus on to driving. In another study (De Nadai et al., 2022), the researchers have not explicitly detected the emotional states of the drivers but have aimed to identify the Sympathetic Nervous System (SNS) and Parasympathetic Nervous System (PNS) responses where SNS responses are influenced by alarm situations such as struggle, drowsiness, stress, etc. while PNS responses deal with the absence of danger. In this research, ECG signals and driver position have been utilised in monitoring the emotions of drivers on line roads and two different drivers have been involved, and fifteen trips on two daily sessions were conducted in conducting the experiment. And with the ECG signals, Heart Rate Variability (HRV) signals are monitored to identify the emotional states of the drivers.

In the research conducted by (Lotz et al., 2022), the classification of emotional states is done concerning that all the positive emotions fall into the positive category while the negative emotions have been categorised into frustration/anger and anxiety/fear. This study has focused mainly on four emotional states, namely, neutral, positive, frustrated, and anxious. Further, neutral has been considered as the emotional state that mostly occurs in drivers. In order to collect data for the research, audio, video and physiological signal recordings in real-time and in-car have been used. Nevertheless, a limitation that was found in this study is that although 'frustration and anger', and 'anxiety and fear' have a difference in the psychological point of view, the authors have not taken that into consideration.

Furthermore, approaches taken by researchers in inducing the emotional states of the subjects are observed to be varying. Researchers (Zimasa, Jamson and Henson, 2019) have utilised music, and mental imagery in inducing the moods in their research and mind wandering theory has been used in order to identify the car following behaviour and driver glance patterns when influenced by neutral, happy, sad, and angry moods while car following.

The authors (Nisa' Minhad, Hamid Md Ali, Ooi Shi Khai and Anom Ahmad, 2016) have concerned on Skin Conductance Response (SCR) signals in human emotion classification for automotive drivers, and according to the authors, happiness, sadness, disgust, fear, and anger emotional states influence risky driving. Imagery, video, audio and video stimulus techniques have been used in this regard. According to the results obtained from the study, SCR processing is with more than 70% of accuracy than the previously stated methods in detecting the driver's emotions. Further, as stated by the authors, risky driving, speeding, and fatigue have been recognised as the major reasons for traffic accidents in Malaysia.

Research focusing on taxi drivers in Japan has been conducted to examine how emotions are associated with the driving speed of the drivers. The researchers have examined five affective states, namely, happy, angry, relaxed, sad, and neutral, using a biometric device. According to the results obtained, anger and sadness that are identified as negative emotions raise the speed of the drivers, while the neutral emotional state influence decreasing the speed of the drivers. Further, happy and relaxed affective states have not shown a notable influence on the speed of taxi drivers (Kadoya, Watanapongvanich and Khan, 2021).

According to the previous studies, it is also observed that researchers have proposed their own emotion models. The authors (Kowalczuk, Czubenko and Merta, 2019) have implemented an emotion monitoring system for drivers using the Plutchik's paraboloid of emotions that the authors have identified as their own emotion model, and the recognition of the emotions identified in the above model has been done using facial emotion recognition and an external algorithm named 'FER algorithm'. Then the Kalman filter is used to estimate the final emotional state of the driver, and the recognised emotion is treated as a measurement data. Further work of this research is to ascertain the influence of the mental state of the drivers on safe driving.

The system proposed by the authors (Bankar et al., 2018) makes use of EEG signals for emotion analysis for controlling the driver's emotional state. The authors of this research are concerned with a two-dimensional model of emotions, and the concern of the authors is for the four emotional states, excitement, stress, depression, and relaxation, where relaxation has been identified as the preferred emotion state for the driver. Further, the researchers propose to use music as a therapy to transform the emotional state of the driver into a relaxation state. El-Amin et al. (El-Amin et al., 2019) have utilised EEG signals of the drivers in recognising driver emotions, and the proposed system has demonstrated its capability to detect two states of emotions, sadness and happiness. The authors state that the extreme expression of these two emotional

states must be discriminated against when ensuring the safety of the drivers.

It is also observed that the researchers focus not only on the driver's emotional states but also on the passenger's emotional states in conducting research on road safety. The researchers (Alyuz et al., 2018) have focused on identifying the affective states of driver-passenger dyads while driving. They have involved 34 participants in 17 pairs in an indoor driving simulator environment to induce affective states during automated and manual driving. The main focus of the researchers has been on the two negative emotional states, namely, frustration and startle, while happiness and neutral emotional states are identified as preferred states. In further works, the researchers target on analysing data to identify gender-specific and scenario-related differences.

Wang et al. (2020) have worked on identifying driver emotions in a two-lane roads scenario with the use of real, virtual, and computer simulation experiments. Fifty-four subjects have been involved in the experimental process, and the emotions were induced using images, audio, etc. According to the authors, this research improves road traffic safety, and the authors seek to improve the system further concerning the extrinsic factors such as weather, road capacity, the personality of the driver, etc. The researchers (Patil and Veni, 2019) have utilised LBP and facial features in detecting the five emotional states, namely, anger, fear, happiness, neutral, and sadness, that they have identified as the affective states that must be detected to enhance the safety of the drivers. Support Vector Machine (SVM) is used as the classification algorithm for both of these researches (Wang et al., 2020) (Patil and Veni, 2019). However, Wang et al. have used an experimental procedure to collect the data for the research, while the Extended Cohn-Kande dataset has been used by Patil & Veni (2019).

4. Discussion

Among the approaches that are prominent in detecting driver emotional states, facial emotion recognition, speech-based emotion detection, GSR, ECG, and EEG signals are much more significant in state of the art. Nevertheless, multiple challenges are encountered when incorporating human emotion recognition for safe driving on roads. Figure 2 represents the challenges to facial emotion recognition as identified by the authors in the reviewed literature (Giannopoulos, Perikos, and Hatzilygeroudis, 2018) (Verma and Choudhary, 2018) (Bhattacharya and Gupta, 2019) (Theagarajan et al., 2017).

Figure 3 depicts the challenges to speech emotion recognition ((Basu, Chakraborty, Bag and Aftabuddin, 2017). The researchers (Vinola and Vimaladevi, 2015) state that audio features and facial and body gestures can improve

emotion detection accuracy. Also, the authors emphasise that gender, age, and cultural differences of humans influence a person's mental state. Moreover, it must be stated that speech emotion recognition is not as appropriate as a driver emotion recognition approach since drivers' speech is not always available while driving. But when integrating other emotion detection approaches with speech emotion recognition, higher reliability can be achieved.
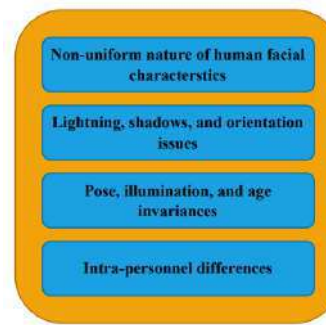

Figure 2. Challenges to facial emotion recognition
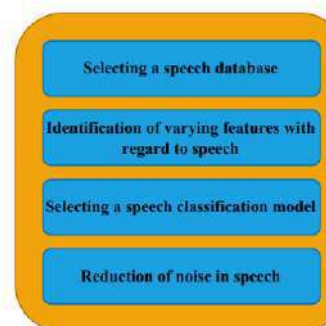Source: The author designed

Figure 3. Challenges to speech emotion recognition
Source: The author designed

Physiological signals can be stated as a more reliable approach since internal emotional changes can be detected accurately through the biological signals rather than the physical characteristics that can be misleading. GSR is a low-cost approach for detecting the emotional states of the drivers, and GSR is sensitive only to the arousal dimension but not to the direction or valence (Ayata, et al., 2017). Nevertheless, in the context of driver emotion recognition, since air conditioning is available in almost all automobiles except for a few, this approach hinders the accurate emotion recognition of drivers.

ECG signals are another approach that many researchers in driver emotion recognition have utilised. Among the challenges with regard to the ECG-based emotion detection systems, the increase in heart rate occurs on fear, excitement, or arousal. Another challenge is that there should be a correct selection between subject-dependent and subject-independent classification procedures (Nikolova., Mihaylova, Manolova, and Georgieva, 2019). Researchers (Zhong, Wang and Miao, 2020) have identified three

challenges in EEG-based emotion analysis, namely, ineffective exploitation of the topological structure of EEG channels to identify varying EEG representations, changing nature of EEG signals across different subjects thereby hindering the generalizability of the already trained classifiers, and not producing the required emotions when emotion eliciting stimuli are being watched. Ethical issues such as the privacy of the individuals may also be affected by the use of these signals; therefore, this should be a significant concern in these systems (Hu, Chen, Wang and Zhang, 2019).

The above-discussed approaches fall under the two general approaches to driver emotion recognition: physiological and non-physiological. Facial and voice emotion recognition fall under the non-physiological approaches, while GSR, ECG, and EEG fall under the physiological signals. Both the facial and voice emotion recognition approaches have the issue of misleading since the way individuals react to particular situations varies from individual to individual. Moreover, the GSR approach has the issue of being inefficient when used in air-conditioned automobiles. ECG and EEG can be stated as more effective physiological signals in the paradigm of driver emotion recognition, although there are some issues that arise from them. Nevertheless, it is also identified that considering the accuracy issues, researchers utilising physiological signals in emotion recognition tend to focus on few emotions in their studies.

Nonetheless, at the same where the authors emphasise the need to address all the emotional states that affect drivers to get into accidents, it must also be stated that human emotions cannot be limited to a few adjectives (Goonewardena and Kalansooriya, 2020) since the emotion classifications are based on how the individuals involved in emotion classification define the emotional states and the main concerns in classifying the emotions. According to the authors (Chunawale and Bedekar, 2020), laboratory-based environmental simulations are not very reliable since the emotions are artificially induced in humans, and even the emotional state felt by an individual in a particular instance differ from another. Reaction time (Saini, Eksambekar, Zahoor and Bedekar, 2016) has also been identified as a significant challenge since the time taken to perceive and react to a situation like an accident consumes a greater time.

5. Conclusion

The findings suggest that multiple researchers have focused on varying emotional states and approaches when the emotion detection of drivers is concerned. Furthermore, some researchers seem to focus on only one emotional state in their studies, while some researchers focus on multiple emotional states that can lead the drivers to get distracted

from regular driving routines. It must be stated that the concern must be on the negative emotional states as a whole but not only on a specific set of emotional states since any external or internal influence that arises in the cognitive domain of the driver may result in a fatal accident that is irreplaceable. Furthermore, when the emotion detection approaches are concerned, both the physical features and physiological signals have been affected by researchers in detecting the driver's emotional states. Nevertheless, it must be stated that it is the physiological signals that are more reliable when determining the driver's emotional states since the physical appearance in terms of facial, speech, gestures, etc. can be misleading since the above factors may depend on the social, cultural, and behavioural aspect of the individuals. Therefore, it is the physiological signals that remain the same for individuals mostly, and authors emphasise the significance of the physiological approach in detecting driver emotional states in real-time by minimising the challenges that arise from them. Accordingly, if a driver emotion recognition system is to be implemented universally, the utilisation of the physiological signals is the most appropriate. Moreover, the knowledge of challenges to emotion detection approaches is also vital in developing such a system.

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Data Retrieval and Analysis to Identify the Associated People of Instagram using Image Processing

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Abstract: In the past three years, Instagram has had the fastest growth of any social network. Users may post photographs with a description, a location, and a few hashtags that did not always correspond to the content of the images to express their status. As a result, Instagram is currently the most widely used photo-sharing platform. Even though Instagram is a rather straightforward service, its ease of use has helped it become so popular all around the world. But regrettably, some individuals abuse our website for immoral activities including the dissemination of false information and fake news, support for terrorism, immoral religious practices, the sale of illegal drugs, etc.So, According to the results of the Literature review we can use the technologies such as Demographic analysis, Text analysis, Image analysis, Snowball Technology and some of the face recognition technologies used in iPhone photos , face recognition technologies such as Eigenfaces technology, Neural Networks, Graph Matching, Line Edge Mapping as the Data Retrieving and Image Processing technologies. So this paper discuss about the implementation of a system to retrieve and analyze image data from Instagram and to identify the most associated people of a certain Instagram user.

Keywords: Instagram, Social network, Face Recognition, Neural Networks, retrieve and analyze image data, Demographic analysis

1. Introduction

Social media has grown to be a hugely significant element of our lives in the modern world. Everyone now relies on social media platforms like Twitter, Facebook, Instagram, and WhatsApp. People share hundreds of photographs, posts, and comments on their accounts when it concerns to Instagram. However, there are situations when these images, posts, or comments have an impact on a national security. This indicates that some individuals misuse Instagram for some illegal behavior, like the distribution of false information and fake news, support for terrorism, illegal religious practices, the sale of illegal drugs, etc. Unfortunately, some of these illicit actions also contribute toward some of the crimes, murders, and suicides.

Particularly with regard to Sri Lanka, these sorts of illicit activities are becoming more prevalent every day. Therefore, it is essential to build a system to retrieve data from Instagram accounts and analyze that data to determine the mostly associated people of a certain Instagram account.

Nowadays, since some people use Instagram for unlawful activities including spreading false information and fake news, supporting terrorism, engaging in immoral religious practices, selling illegal drugs, etc., it frequently has an impact on murders, crimes, or suicides as well. We may thus create a new system that analyzes data from a specific user's Instagram account and predicts the users who are most likely to be affiliated with that Instagram account in order to solve problems of this nature. This system's primary focus is on creating an algorithm with image processing to identify the faces in the retrieved photos and forecast the percentages of the individuals who are most often related. Finally, this method will show the facial image of the most associated person of a certain Instagram users.

When concerning this system it consists with two parts.The first part is the Data Retrieving process and the second part is Image classification and image processing. So, this paper is going to discuss about the implementation of a system to retrieve and analyze image data from Instagram and to identify the most associated people of a certain Instagram user.

2. Literature Review

This section provides an overview of the literature on a number of current data retrieval and analysis technologies and approaches, including the Snowballing method, Binary coding, Regression analysis, Text analysis, and Image analysis. Along with Eigenfaces, Neural Networks, Graph Matching, Line Edge Mapping, and the face recognition algorithms used in iPhone photos.

A. Data Retrieving and Data Analyzing

There have been several studies conducted to extract various types of data from Instagram, evaluate them, and identify the essential information of a particular Instagram image.

Instagram may be used for demographic analysis, language analysis, picture analysis, and age identification, claims a research by Pang et al.(Singh, Halgamuge and Mouss, 2019; Hyanghee Park and Joonhwan Lee, 2017). With the use of several face identification and face analysis

technologies, the photos used in this work were used to examine the demographic. We looked at the tags that match to the photographs. Studying the brand's supporters and drinking habits has helped to increase penetration.

Then, according to study by Park et al.(Singh, Halgamuge and Mouss, 2019), it may be done with Instagram using the Snowballing approach, Binary coding principles, and Regression analysis. (Hyanghee Park and Joonhwan Lee, 2017) A quantitative approach is used to examine the relationship between sexual images and social participation. Additionally, the quantity of likes was used. The snowballing strategy was developed to collect visual information from people. Through the use of binary coding, the images were self-coded. Regression analysis was used to assess user behavior.

A logistic regression classifier using a forward feature selection strategy may be used for Instagram, according to study by Hosseinmardi et al. (Hosseinmardi *et al.*, 2016; Singh, Halgamuge and Mouss, 2019).The initial posts are used to gather information. Using LRC, a predictor was learned. To evaluate the behavior, Instagram comments, photographs, and followers were used. Bigrams and unigrams were highlighted.

It is an Instagram profile verifier while taking into account the research INSTAFIER.(Aggarwal, Upadhyaya and Aggrawal, 2019) By providing pie charts for each component test, the authors of this study analyze an Instagram profile and give a thorough analysis of the account. Therefore, it is simpler to understand the account when using these pie charts.

B. Face Recognition Technologies a) Face Recognition Technologies use in iPhone Photos

The majority of iPhone images utilize face recognition and image similarity checking processes. Face detection was first developed by Apple and is now available as a public API through the CIDetector class in the Core Image framework. Additionally, Apple used this API internally in programs like Photos. The original iteration of CIDetector used the Viola-Jones detection method. (Viola and Jones, 2001). Deep convolutional networks (DCN) were only beginning to show promise on tasks that required object recognition when the development of a deep learning approach to recognize faces in pictures began in 2014. The most important of these was a technique called "Overeat" (F, F. and G, 2013), which made numerous straightforward ideas well-known and showed that DCNs were incredibly effective in searching an image for an object. Network-innetwork technology is another one that is used (Turk and Pentland, 1991). It would be completely impossible to use such a network using the previously suggested photo scanning technology. Low efficiency and high energy use

were the results. Even trying to store the network in memory would be impossible. With it, they attempted to use the "teacher-student" training method (Patil and Deore, 2013). This technique gave them a mechanism to train a second thin-and-deep network (the "student") so that its outputs nearly resembled those of the vast, complex network we had previously trained (the "teacher"). Finally, they created a deep neural network face identification method that could be used on a mobile device. To build a network model accurate enough to handle the targeted applications, they went through multiple training cycles. Even though this network was accurate and workable, it took a lot of effort to have it installed on millions of consumer devices (Sung and Poggio, 1995).

b) Eigenfaces

Another technology that has been the subject of substantial research for facial identification is eigenface. The Karhunen-Loève expansion, eigen image, eigenvector, and major component are further names for it. In the references (Bruce, Hancock and Burton, 1998; F, F. and G, 2013) principal component analysis was used to depict images of people's faces. They argued that by employing a basic set of weights for each face and a representative image of the face, or the eigenpicture, each face image could be roughly reconstructed. The weights defining each face are obtained by putting the face image on the eigenpicture. Kirby and Sirovich's approach was the source of inspiration for Reference (Turk and Pentland, 1991), which used eigenfaces for face detection and identification. They stated that a face image could be roughly reconstructed by utilizing a standard face shot and a small set of weights for each face. The weights defining each face are obtained by projecting the face image onto the Eigen image.

c) Neural Networks

The usefulness of using neural networks may be connected to their nonlinearity. The feature extraction stage may therefore proceed more quickly than the linear KarhunenLoève techniques. One of the first artificial neural network systems for face identification was WISARD, a network with only one layer of adaptation and a separate network for each stored person (Patil and Deore, 2013). For accurate recognition, the technique utilized to construct the neural network structure is essential. It greatly depends on the intended usage. Multilayer perceptron (Sung and Poggio, 1995) and convolutional neural network (Lawrence *et al.*, 1997) have both been used to recognize faces. In reference (Lawrence *et al.*, 1997), a hybrid neural network was presented that combines local image sampling, a selforganizing map (SOM) neural network, and a convolutional neural network. The SOM reduces the dimension and makes the picture sample insensitive to small changes by quantizing the image samples into a

spatial region where the input data that are near in the original space are similarly close in the output domain. The convolutional network collects successively larger features and provides partial invariance to translation, rotation, scaling, and deformation in a hierarchical succession of layers.

In the PDNN (F, F. and G, 2013) learning scheme, there are two sections. Each subdomain is taught at the initial step using its own set of facial photos. In the second step, referred to as learning based on decisions, particular sample data that was gathered from various classes of faces may be used to learn the subdomain parameters. Not all training examples are used in the decision-based learning technique. We only use patterns that have been misclassified. Any sample that is improperly assigned to the wrong subdomain will cause that subdomain to change its settings. As a result, its judgment is closer to the sample that was mistakenly categorized.

A PDBNN-based biometric identification system combines the advantages of statistical methods with neural networks, and its shared computing concept is straightforward to implement on a parallel computer. According to (ShangHung Lin, Sun-Yuan Kung, and Long-Ji Lin, 1997), the PDBNN face recognition system could identify up to 200 people and achieve a 96 percent accuracy rate in around a second. However, if more individuals are added to the population, the cost of computing will increase. In general, as the number of classes increases, neural network algorithms encounter problems. However, they are inadequate for a single model image recognition test since taking several pictures of each model is necessary to train the algorithms to "optimal" parameter values.

d) Graph Matching

Graph matching is another technique for identifying faces. In order to identify deformation-resistant objects, (Lades *et al.*, 1993) presented a dynamic network structure that uses graph matching to find the closest recorded graph. An alternative to conventional artificial neural networks is referred to as dynamically networked architecture. Memorized objects are represented as sparse graphs with edges labeled with geometrical distance vectors and vertices labeled with multiresolution descriptions expressed in terms of a local power spectrum. Object recognition may be described as graph matching, which is carried out by stochastically minimizing a matching cost function. They claimed successful results using a database of 87 individuals and a small group of office supplies made up of different phrases rotated by 15 degrees.

The matching process is computationally demanding and takes around 25 seconds on a parallel computer with 23 transputers to compare with 87 stored items. Reference(F,

F. and G, 2013), which compared human faces to a gallery of 112 neutral frontal view faces, extended on the strategy. The probe photographs were deformed as a result of the face expressions changing and the depth rotation. On faces with sizable rotation angles, positive outcomes were discovered. For matching tests of 111 faces rotated 15 degrees and 110 faces rotated 30 degrees to a gallery of 112 neutral frontal pictures, respectively, they reported identification rates with the percentage of 86.5 and 66.4. Dynamic link design surpasses traditional face recognition systems in terms of rotation invariance, but the matching process is computationally expensive.

e) Line Edge Map (LEM)

An effective object representational aspect that is mostly unaffected by changes in light is edge detail.

With the exception of recent work given in (F, F. and G, 2013), the edge map has mostly been disregarded in face recognition while being widely used in many pattern recognition domains.
The precision of object edge pictures is comparable to that of grayscale photos, making them useful for object recognition. In reference (F, F. and G, 2013), edge maps were utilized to evaluate how similar facial images were. The accuracy percentage was 92%. Takács argued that the process of face recognition may start much younger and that edge images may be used to distinguish faces even when high-level cognitive capacities are not involved. (Yongsheng Gao and Leung, 2002) suggests a method for extracting lines as features from a face edge map called Line Edge Mapping. This approach may be viewed as a cross between template matching and geometrical feature matching. The LEM methodology not only has the advantages of feature-based techniques, like invariance to illumination and low memory consumption, but it also performs exceptionally well in template matching recognition.

By dividing the pixels in the face edge map into line segments, the Line Edge Mapping technique integrates the structural and spatial information from a face image. A polygonal line fitting approach is used to produce the LEM of a face after limiting the edge map [15]. An example of a human front face Line Edge Mapping is shown in Figure 1. The LEM representation needs less data since it just saves the termination locations of line segments on curves. Additionally, LEM is expected to be less sensitive to fluctuations in light as it is a middle-level image representation technique built from a bottom-level edge mapping representation. The basic building block of LEM, which is composed of pixels from the edge map, is the line segment.

For usage as a preprocess of Line Edge Map matching before facial recognition software matches faces, a face prefiling method is given. The prefilering approach may speed up the search by reducing the number of applications, while the actual face matching is only done on a portion of the remaining models.

The recommended Line Edge Map often beats the edge map in tests on front views of the faces conducted under controlled or ideal conditions. LEM correctly recognizes between 96.43 and 100 percent of the input front views of the faces in face databases (Yongsheng Gao and Leung, 2002). For faces with optimal settings, Line Edge Map performed comparably to the Eigenface method, and much better than the Eigenface method for faces with modest variations in appearance.

(Yongsheng Gao and Leung, 2002) illustrates that for face detection under different lighting situations, the LEM technique performs better than the eigenface approach. Similar to the eigenface approach, the LEM technique is less sensitive to changes in posture, but it is more sensitive to significant changes in facial emotions.
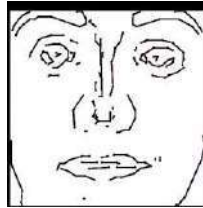

Figure 1 Line Edge Mapping Illustration

Table 1 Comparison on Face Recognition Technologies

Technology	Advantages	Disadvantage
Eigenfaces	• Simplicity is high. • Effective • Save time and space	• Sensitive to lighting conditions and head position.
Neural Networks	• Accuracy is high. • Feature extraction is more efficient. • Classification time is very low.	• Much storage is needed.
Graph Matching	• if any of the features change or are missing, the people will still be identified	• Sensitive to lighting conditions
Line Edge Map	• Insensitive for the lighting conditions. • Cheap memory requirement.	• Computing requirement and the specifications are high.

Therefore, Neural Networks will be the best face recognition technology for this system based on the analysis of the benefits and drawbacks of the face recognition technologies discussed above.

3. Proposed System and Methodology

The proposed solution is consist with two main parts.They are;

Image Retrieving and Scrapping Process 2.Face Recognition and Face Similarity checking process.

A. Image Retrieving and Scrapping Process

The practice of deploying bots to gather information and material from a website is known as web scraping.Web scraping collects the underlying HTML code and, with it, data kept in a database, in contrast to screen scraping, which just scrapes pixels seen onscreen. After that, the scraper can duplicate a whole website's content elsewhere.Many digital firms that rely on data gathering utilize web scraping.

When concerning the Instagram Image Retrieving and Image Scrapping process we can use different type of web scrapers.They are;

- Selenium
- Playwright
- Beautyful Soup
- Mechanical Soup

So among the above mentioned web scrapers the best web scraper for the processed solution is Selenium web scraper. By using this Selenium web scraper the system can scrape all the images of a certain Instagram user to a database or a local space.

B. Face Recognition and Face Similarity Checking Process

When concerning this face recognition and face similarity checking process, mainly it focusses on image classification process.

In this proposed system, first we scrape all the images of a certain Instagram user and then start to find who are the associative of a certain Instagram user.So, after scrapping all the images of a certain Instagram user, the system will classify all the Positive and Negative images from those

scrapped images. In here positive images means images with human and negative images means images without out human.As the system needs only the Positive images, it will classify all the positive images.

After classifying all the positive images, the system will take an input facial image of the person that we need to find who are the associatives of that person.

After taking the input facial image, the system will again classify those scraped images to identify whether the input's given person is available or not available in those images.In this stage as the system only needs the images with the person is available, so that it will classify all the images that the input's given person is available.
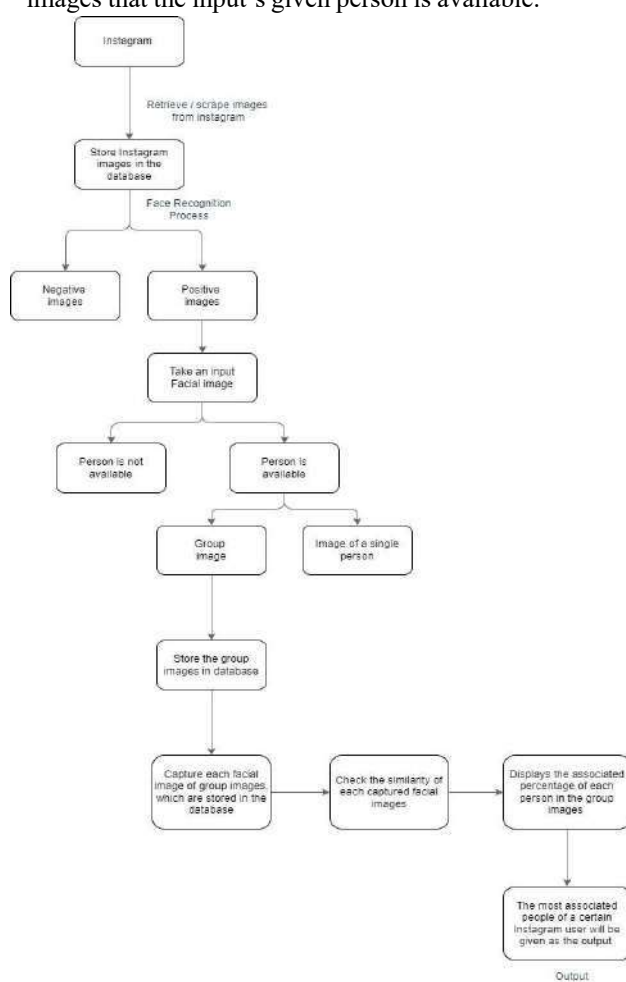

Figure 2 Overall Proposed System

So with reference to Figure 2, if the input's given person is available in those images then again the system will check and classify whether those images are individual images or group images.After that, the system will classify all the group images.

So, then the system will capture all the facial images of each person in these classified group images and finally take the overall percentage of those facial captures and display who are the most associated people of a certain Instagram user.

4. Results and Implementation

According to the results of the comparison on the face recognition technologies in Table 1, the most suitable technology for this proposed system is Neural Networks. Because the Neural Networks are the most suitable face recognition and face similarity checking technology for this system.

Also, when comparing the web scraping tools such as Selenium, Beautiful Soup, Mechanical Soup and Playwright, the most effective and matching scraping tool for this system is Selenium web scraper.

5. Conclusion

Instagram is currently the most widely used social media platform in society. Sadly, some individuals misuse it for a variety of illicit actions. However, some of these illicit acts are the root cause of crimes, murders, suicides, etc. Therefore, it is essential to build a system to retrieve data from Instagram accounts and evaluate that data to determine the major associates of each account.

Technologies for data retrieval, analysis, and face recognition are widely employed in the modern world for a variety of purposes. In this paper various Data Retrieving, Analyzing and Facial Recognition algorithms are discussed, along with their benefits and drawbacks and this paper gives a clear idea about the proposed new system for identify who are the most associated people of a certain Instagram user by Image Processing.

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An Augmented Reality based approach towards Furniture Shopping

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Abstract: *In the furniture industry, all the companies have been involved in furniture designing, manufacturing, distributing, and selling decorative household equipment. But the furniture industry is one of the major industries facing challenges these days. The researcher has gone through the existing and current furniture selling applications. The researcher has done interviews, observations, and questionnaire distribution among furniture sellers and clients during the process of identifying the problem. So, purchasing the best suitable furniture item according to the customer expectation is the main challenge that people has faced during online purchases. That means, it can be challenging to visualize how furniture will look in our homes and work with the décor already in place. Researchers pointed out that augmented reality can quickly resolve this problem. The usage of augmented reality in industrial applications is still relatively limited in a world where technology rules. Augmented reality is a field of image processing that deals with the combination of the real-world and virtual environment. Researcher has used ARCore plugins through the furniture item visualization. Users will be able to see how the item will appear in their space in real-time. The researchers' aim was to implement an application for smartphones to assist customers who purchase interior items directly online by allowing them to virtually see how their area will look after making the purchase. After implementation, researcher compared this developed system with the related current world applications and scenarios in the system evaluation process. Those system evaluations shows that the proposed system will be more supportable to make the current furniture industry more profitable.*

Keywords: *Augmented Reality, AR Furniture, ARCore*

1. Introduction

Each household and its individuals of it have an essential need for furniture. Nonetheless, the majority don't browse furniture stores frequently. If people need to invest money and give it more thought before purchasing it, it makes absolute sense. Since customers rarely return, the shop should occasionally alter its products to maintain its customers' experiences enjoyable. In this project, the center will provide clients who need furnishings with the best possible experience. The concept is based on Sri Lankan furniture stores that use well-known furniture manufacturers there. Here, the researcher will talk about the typical practice of implementing current systems when discussing the entire perspective of the online furniture store. Such an online furniture store application often allows users to search through the various pieces of furniture that are offered by the retailer. A customer must register with the system once they want to check out. A selection of furniture items in various models and designs are available in that store. Users can browse the products by category because there are numerous products in each one. The consumer has the option to add a product to his shopping basket if he likes it. Users could then complete the payment. Finally, customers have payment options. So other than above mentioned normal procedure this will improve the customer interaction by adding the feature of taking the real-time experience of the object. The special feature of this application is, that the application can detect the measurements of the real surface area and adjust the 3D furniture model in accurate scaling. The major objectives of the research are, to recognize and compare the features of the existing and current furnished eCommerce applications, understand the usage of ARCore, and make use of the Sceneform SDK, which includes a PBR (physically based renderer) to facilitate the process of presenting products in the actual world and take the accurate scaling of both the 3D furniture model and the surface area in which it will be placed.

2. Literature Review

A. Feature extraction of existing and current applications

These findings further support the idea of implementing the furnished e-commerce AR Application. The work of "Houzz Interior Design Ideas" by Reuksupasompon, P et al (2017, pp.1-6) is an AR furniture store application that allows users to place virtual furniture products in their surroundings. The procedure behind this application is simple. The application requires users to first take a snap of any preferred location of their home, then position the virtual furnishings by hauling it to the ideal place and planning the presentation utilizing two fingers to resize the furniture product. Furniture will appear on the top of the selected background, with the ability to move and resize the overlay image. The strengths of this application were, that it is very easy to use, it simply shows the user the way of working and it can be downloaded easily because of less storage. Limitations of this application where this application does not support 3D views. It still uses flat 2D images and does no scale relative to the real word environment. The present study by Cruz, E. (2019) makes several noteworthy contributions to getting a 3D view of furniture products and it can be automatically scaled to fit the size of a real-world environment at a 1:1 ratio. It is an IOS application which is named "Furniture Drop: AR Room Planning App" invented by Asher Vollmer. This application uses the ARKit framework which was recently developed by Apple. It can integrate the iOS device camera and motion features which help to create an immersive experience of augmented reality in an application. When discussing the constraints of this application it only supports a limited number of devices.

More recent attention has focused on the IKEA application which Ozturkcan, S. (2021) is a famous IOS application developed by using ARKit SDK. It helps customers to do a product review before they obtain it by scanning any specific product, customers will then get associate AR expertise. By incorporating AR within the promoting strategy, mechanically a buzz is formed concerning the whole since the technology goes on the far side of the standard tools that area unit utilized by marketers, it provides associate expertise as on the brink of the important issue as is.

One study of Jerome's Furniture company they examined on the "Jerome's furniture Smart Shopper" Besecker, B & Marxent (2019) is an application created by them. The strength of this application is wherever this application permits users to rotate the chosen virtual model and perceive it at a special angle. Application has the flexibility to mechanically scale the virtual object and drag it. However, these applications square measure poorly in position detection and poor in object and surface scaling.

The Roomy, Hanni A.R (2016) convenient app was designed for skilled designers. It has the flexibility to convert second pictures to 3D scenes. Shoppers will have the read the article on furniture and decoration in AR and buy the things.

One of the biggest online merchants within the USA and the world is Overstock.com, Inc (2020). Through its websites and app, the business offers the available article of furniture, merchandise for the house, and created designs. Customers will utilize the stock.com app to use increased reality modeling to examine the furniture and alternative ornament elements that can work into the general house style. Photorealistic 3D models accurately represent the products' size, texture, and practicality. The Overstock app is critical because it delivers particular in-app expertise, together with special coupons and offers, searching suggestions, Club O account-related advantages, bit ID access, and more. Interior design is approagamifiediedly by DecorMatters application ApkDeal. (2022). This no-cost app offers a few pictures of empty rooms that you can decorate by placing furniture in the simulation world. Upload pictures of your actual furniture into the application, then stand back and observe as it creates a 3D model of your area to include a picture of your own home. Professional designers frequently utilize Homestyler, Tong, H. et al. (2019), but novice interior designers and homeowners can also benefit much from this program. With Homestyler, customers can take a picture of their present space and have it rendered in 3D, taking augmented reality-powered design one step further. They can then choose things to add to an environment with a few quick taps. You can quickly swap out parts within the program, change layouts, and move objects around. This is a great option for those wishing to completely rebuild the space because it enables customers to see the entire space at once. Professional designers were the target audience for the Roomy App, Hanni A.R,(2016). It can turn 2D photos into 3D environments. Customers can view furnishings and décor in augmented reality and buy things.

Table 1. Summary of the features of the applications

Application	Strengths	Limitations
Houzz Interior Design Ideas (Reuksupasompon, P et al 2017, pp.1-6)	Very easy and fast to use. Support a wide variety of devices.	Does not support 3D views. It still uses flat 2D images and does no scale relative to the real word environment.
Furniture Drop: AR Room Planning App. (Cruz, E.,2019)	Supports getting a 3D view of furniture products and it can be automatically scaled to fit the size of a real-world environment at a 1:1 ratio.	Only supports a limited number of devices. Issues in taking the accurate measurement of the surface and the item.
"Jerome's furniture Smart Shopper" (Besecker, B & Marxent, 2019)	Support 3D rotation Support automatic scaling	Poor in position detection.
Wayfair (Vazquez, C., Tan, N., & Sadalgi, S. ,2021)	Focuses on offline showrooms and the shopping flow.	User experience is really bad in the terms of UI design.
Housecraft (Critic, A., 2022)	This ARKit app has nice visual feedback that shows you the progression of the scan. Once the app can complete the scan, this is the time when you can start putting 3D models in the scene.	Ability places a few items once on the surface.
EQ3 (Roberutsu.com. 2022)	AR reception by refreshing their work area item page and making a spring up with a QR code that exhibits imaginative style.	Loss in Surface detection. Issues in taking the accurate measurement of the surface and the item
IKEA Place (Ozturkcan, S.,2021)	3D images are quite accurate and can convey real-life sizes. Drag and drop functionality. Accurate Scanning.	Complexity in usage.
Roomy (Hanni A.R,2016)	It can convert 2D images to 3D scenes. Clients can view the furniture and décor in AR and purchase the items.	Complex to use. Much heavy application. Issues in taking the accurate measurement of the surface and the item
DécorMatters (ApkDeal.,2022)	Can upload their furniture and decorations Design their rooms by themselves	Focus mainly on 2D models.
Homestyle (Tong, H. et al,2019)	This application can convert the photo of your room into a 3D scene where you can place a 3D model into your picture offline.	Having bad user interfaces.

B. Comparison of ARCore and ARKit

When going through the technologies used in existing and current furniture apps for taking the real preview of the furniture, there are mostly used augmented reality technology to visualize the furniture items. The investigation shows that the usage of ARCore and ARKit took a prominent place. So, the researcher has gone through a comparison of the importance of the features of the ARCore and ARKit.

A range of commercial use-cases are presented to AR developers by the ability of ARReferenceImage in ARKit and Augmented Images in ARCore to recognize and superimpose 2D virtual photographs over original images in real-time. Both of these tools are compatible with many mobile frameworks, and both are capable of detecting changes in illumination and gaining access to motion sensors. But when it relates to mapping, ARCore surpasses ARKit. Through the collecting and storing of 3D environment data, ARCore's larger mapping dataset enhances the speed and consistency of mapping. The amount of local condition information and data stored by ARKit is less. However, this discrepancy was masked by the ARWorldMap functionality that debuted in ARKit 2.

As here researcher going to develop an android application, ARCore has the features which are supporting for building the android approach than comparing the supportability of the ARKit. Additional features are plane detection, point detection, light estimation, hit testing, image tracking, 3d object tracking, face tracking, and identification of environmental problems. So, the researcher identified that ARCore is better for using to ease the tasks and achieve the best performance in this implementation.

Supported features	AR Foundation	Google ARCore SDK for Unity	Unity ARKit Plugin	ARKit for Android	ARCore for Android
Plane Detection (Vertical)	✓	✓	✓	✗	✓
Plane Detection (Horizontal)	✓	✓	✓	✗	✓
Feature Point Detection	✓	✓ + Oriented Feature Points	✓	✗	✓
Light Estimation	✓	✓ + Color Correction	✓ + Color Temperature	✗	✓
Hit Testing (Feature point and plane raycasting)	✓	✓	✓	✗	✓
Image tracking	In development	✓	✓	✗	✓
3D Object Tracking	In development	✓	✓	✗	✓
Environment Problems	In development	✗	✓	✗	✓
Worlds Maps	✓	✗	✓	✗	✓
Face Tracking	✓	✗	✓	✗	✓
Cloud Anchors	In development	✓	✗	✗	✓

Table 2. Comparison of features of ARCore and ARKit

3. Methodology

For this study, it is far more effective for the researchers to use the research onion model as an explicit research approach. Enhancing the performance of the android application for the furniture industry is the basis for the research's guiding principles. The researcher uses a positivist research philosophy and holds the belief that only factual knowledge can be learned by observations and measurements. The researchers utilized a deductive strategy in this study to explore by looking at the furnishing e-commerce applications that were created and used by the experts. Researcher adopt a strategy to identify the issues in the current systems. The hypothesis of this approach to increase the user interaction of the furniture e-commerce application by taking the real-time preview of the furniture item according to the accurate scaling. The researchers employed a variety of research techniques, including

surveying the target audience, comprehending the algorithms and grounded theories that were applied, having a clear grasp of the existing situation, and concentrating on the most effective way to fix the problems at hand. The ethnographic method of addressing the clients' backgrounds, customs, way of life, behavior, shared distinctions, and various points of view. Time horizon takes a major part in research for a while, here a cross-sectional time frame was used. The researcher used some techniques in data collection and data analysis were discussed below. To appropriately determine the processes of furniture selling applications, and users' requirements, quantitative and qualitative methodologies are applied.

The sample population of the study consists of customers and the furniture shop administration, they are the main stakeholders of the app-using process. By utilizing primary sources, such as semi-structured interviews, in-person interviews, questionnaires, and direct observation of the chosen sample, the community's first-hand perceptions were primarily gathered. Secondary sources are used as the second method of information collection. Based on the comments already given by the customers, app viewers, and furniture shop administrators, secondary data was gathered. Additional details about the current systems can be found in personal records, client histories, and service records. By looking at comparable systems and fact-finding methods, the requirements for the mobile-based feedback system are gathered during the literature review. Agile methodology is used during the development of the system as it reduces the developer's effort and time required to detect and correct the errors.

A. Proposed System Background

Here the researcher specifies the software requirements which were needed to build the project, the concepts which could be applied, and a brief explanation of the overall outcome of the procedure of the project.

A. Android SDK

Important implications for developing applications for the Android Platform are provided by the Android SDK (Software Development Kit).

The following are some of the Android SDK's key elements:

a) SDK Build Tools: This is a combination of all the tools needed to build every individual application component.

b) Android Emulator: This is a virtual device used to test the android application in the development environment itself.

c) Platform Tools: These are the tools that offer assistance for using the current Android API with an application.

d) SDK Platform: The application's intended API level (Android level)

e) Google APIs - By offering APIs which were supporting the building interfaces which is important in simplifying the app implementation.

B. Sceneform SDK

OpenGL API which is used in the creation of 2D & 3D vector graphics is generally needed to build AR applications in android. So Sceneform SDK makes supportable for the process naturally fluid and enables users to create dynamic AR applications without having to learn about OpenGL.

Scene from SDK is made up of three main parts: a physically based renderer provided by filament, a high-level scene graph API, and an Android Studio plugin that integrates the SDK with Android Studio for the aforementioned development process.

C. Scene graph

A scene graph is simply a data structure that is employed in vector graphics applications. Nodes are a 3D graphics technique that can be used to specify the connections between virtual objects. In this furnished application, transformable nodes will be used to anchor the 3D objects into the scene, along with scaling and transformation ability.

D. Physically Based Rendering

It is a form of rendering approach that ensures the accuracy of the lighting for all 2D and 3D models in the display. Thus, PBR enables the enhancement of textures, shadows, reflections, and other environmental effects to depict objects in the environment. Different surface kinds, including metals and hardwood surfaces, look lifelike.

E. ARCore

ARCore allows Android smartphones to use augmented reality (AR) features without the need for any additional sensors. The usage of sensors which available for developing ARCore-related project. ARCore has improved Tango, which was previously utilized to allow augmented reality on Android devices. With the aid of the on-device cameras, ARCore uses the scenes to import 3D objects into the application and create models in real-time that are projected into the environment. In ARCore, three fundamental ideas are applied: Object tracking, Light Estimation and Environmental understanding.
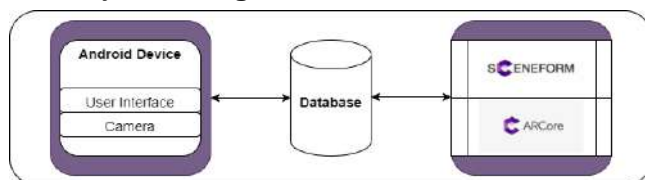
4. System Design

Figure1. System Architecture

A. Camera & Android Device

To run this application with proper functioning there should be a mobile device with Android 7.0 or higher API level 24 which has high-quality features.

B. User Interface

The layout of the user interface should be sufficiently interactive with the user. The application should follow the standard procedure and interfaces of the E-commerce application.

C. Database

The database must be consistent to record information about users, transactions, and products, therefore firebase was selected for this furnished application. Firebase is ideal for testing the various components of the application. As Firebase is free of any data restrictions and easily compatible with mobile applications.

D. Sceneform

Accurate and realistic scenes may easily be rendered in AR and non-AR apps thanks to Sceneform. The main scene form dependencies that are available for adding the project were scene form core, plugin, UX, and assets. Instead of making a unique asset file (.sfb) for each model, this method integrates with Google's ARCore and produces a model at runtime.

E. ARCore

The researcher takes several procedures to display the model through ARCore. Below, the author briefly discussed the workflow for displaying the AR model.
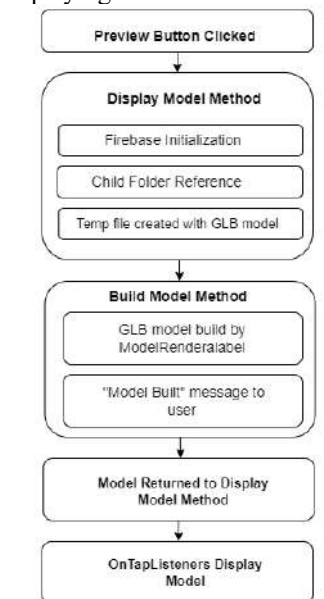

Figure2. Block diagram to display AR model

a) Real-Time Preview Button Press: After reviewing the product details of the app, Customers can access the AR fragment page by clicking on this button.
b) Applying the DisplayModel method
   a) Initialization of the Firebase database.
   b) 3D model attached to the child node of the scene graph.
   c) A temporary file with the. The global extension is made, into which the model file will be downloaded.
c) BuildModel Method: The 3D model is constructed at runtime using the build model method after the model file is downloaded from the database and received into the temporary file.
   a) The BuildModel method's ModelRenderable constructs the 3D model using the file supplied at runtime.
   b) A node in the scene graph has the model associated with it.
   c) The model is then delivered to the technique that displays models.
   d) The user receives a notification letting them know the model has been built.
   e) On Tap Listener: The model is simply shown on the tapped node in the AR fragment when the on-tap listener is enabled. Transformable Node is utilized, making it

feasible to resize and move the model horizontally over the scene graph.

5. User Flow

A. Login/Register

Customers and Admin should register for this system by themselves by entering their username and password as they preferred. Those usernames and passwords are used to log in to the system. If required users can change their passwords after login into their account. The login function should be used to access system users to log into the system. Users should already be with their usernames and passwords.

B. Home Page

After the successful login, the user can view the home page displayed with all the categories, subcategories, promotions, and offers of the furniture products.

C. Categories

The categories page is available with main categories and subcategories. The administrator has the authority of all the crud operations of handling the category page. The user can easily browse through each of those categories. When clicked on each one opens a recycler view that pulls items from the database using the specific category name.

D. Product Selection

When a product is chosen from the recycler view on the home page or any of the categories, the product details activity, which contains the product's details, opens. The activity gets the product id from the prior activity as an extra intent string. Product name, description, price, image, and connection to the AR object contained in the firebase storage are all fetched by the product details class.

E. AR preview

Before taking the preview of the object, the user should measure the surface area in which the object is going to be placed. It can be done by adjusting the width and height of the cuboidal shape that appeared in the user's area. Then the user can gain an idea of the size of the furniture which is suits for this place. Then users have the ability to search through the different sizes of the same product. This is the main function that this application makes differs from other applications. Then users have the ability to gain a real preview of the furniture item. Additional functions beyond the previewing were 3D rotating, adjusting the sizes, scaling, drag and drop ability and detection of the horizontal surface for placing the furniture item.
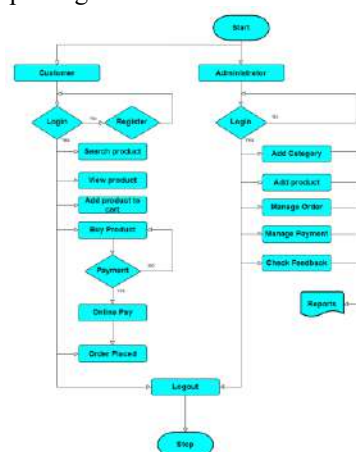
F. Checkout:

Customers can add a product to their cart after thoroughly inspecting it. The product and the person whose information was added to the cart are both added to a database when the add to cart button is clicked. At the bottom of the cart page, the total is visible. If the customer is happy with the merchandise, they can check out. The administrator has the ability to preview the details of the products.

6. Implementation

This furniture application is deployed in 3 states as explained below.

A. 3D model Creation and Collection

The developer should collect the 3D models of furniture items of various categories such as chairs, tables, beds, etc. in glb format to be displayed in each item in the catalog. For the creation of the 3D model's developer used the Revit software and using websites.

B. User Interface Creation

The main pages of the furniture e-commerce application are the Login page, registration page, home page, categories page, product page, product details page, cart page, and payment details page. All the UI should be simply designed and developed according to the basic requirements of the clients. The process of this application is somewhat new for all the Sri Lankans. Therefore, for easy acknowledgment of all the people, developer used many techniques in developing UIs by showing the process of the application.

Figure 3. User Interfaces

C. Insertion of products into the categories.

After an assortment of product knowledge, an interface was created to change the process of uploading the info to the base database. The permission to feature any product knowledge to the information is proscribed to solely the administrator, whose credentials are often created on the server aspect of the base. The administrator is ready to log in through a separate login page and then the user login page. Upon thriving authentication and login, the administrator is ready to feature the merchandise information to the information through the add product page. The product added to the information will then be accessed by all registered users via the application itself.

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Figure 4. The interface of product selection and cart
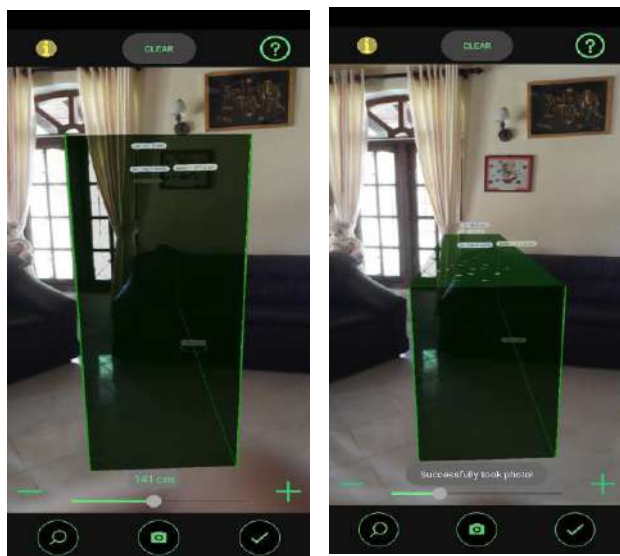
D. Tanking the measurements of the surface area.

Figure 5. Interface of 3D model scaling

The app can take measurements of the area including the height, width can be measured. You can adjust the area size until it suits your preference. You can get marked the measurements of the area you going to keep the furniture item. Then when selecting the item customer can consider the size of the item also. It is a major advantage of this proposed application that the above-mentioned existing applications.

E. Screenshot of Chair AR model Prototype in AR Fragment.

The application's outcome, including the textures and colors, is of high quality and was made possible by the use of GLB models. Due to excellent light estimates, the chair's reflections and shadows in the AR fragment are accurate. The chair's leather can appear sparkling thanks to the use of PBR. Since the model was produced at runtime, it has an average density in terms of complexity. Devices with more processing power and a larger database bandwidth can be employed to achieve higher complexity models. Due to excellent light estimates, the chair's reflections and shadows in the AR fragment are accurate. The chair's leather can appear sparkling thanks to the use of PBR. Since the model was produced at runtime, it has an average density in terms of complexity.

Figure 6. 3D Real-time preview of furniture model

7. Results and Evaluation

For the evaluation of the accuracy of the system researcher has tested the furniture item in real time preview by keeping the mobile phone in every environment. Here given below is the evaluation of the 3D model real time preview features of the application.

Here researcher has taken the different angles of the object by placing it for the different places. Here given below are some of the sets of real time preview of the objects. It shows that the object identifies any plane surface accurately, the object can be rotate and drag into any place you want. Here researcher shows that the object can be place in both mid dark places and more bright places. The size of the object can be compared with the other equipment's in the surface. The size of the object can be adjusted by using the hand and always the size is displaying on the object as a percentage in size adjusting. Here researcher shows that the shadow of the object can place in each and every object. So, the researcher shows that this system has more accurate features of showing the real time preview of the furniture item.

Figure 8. Evaluation of Real-time preview of furniture model

Researcher has done the evaluation process in different ways. Researcher has been compared the developed system with set of related real-world scenarios' functional and non-functional requirements. Researcher has shared the above implemented system with the furniture shops which were used to gather the requirements in the requirement analysis process.

The complete system evaluation results were mentioned below. Here the system has given for a set of furniture shoppers who are engaging in selling their furniture items using the applications. Here the sample population was eight furniture shops.

Note: the mean score is calculated from respondents' feedback on Five-scale questionnaire: 1 (Strongly Disagree), 2, 3, 4 and 5 (Strongly Agree).

Functionality of the system	Mean Score
Customer account management	4.1
Admin account management	4.2
Products category management	4.4
Products management	4.6
3D visualization of the furniture item	4.8
Cart management	4.8
Payment management	4.7
Reports management	4.5
Feature of 3D object visualization	**Mean Score**
Plane surface detection (Horizontal & Vertical)	4.8
Furniture model rotation	4.9
Resizing the furniture model	4.7
Light Estimation	4.7
Dragging the product for any environment	4.6
Object tracking	4.7
3D model scaling	4.8
Click and drop the selected product	4.8
Model place can adjust using the fingers	4.7
Cloud storage support	4.6

Table 3. System Evaluation Results

Given below is the features comparison of developed system with related real time applications which was done by the researcher. It shows the level of the developed system with other current systems.

Functionalities of the system	Develop App	IKEA	Houzz	Roomy	Décor Matters	Wayfair	Home Craft	Ethan Allen inHome	uMake	Jerome's furniture Smart Shopper	House Styler
Customer account management	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Admin account management	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Products category management	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Products management	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3D visualization of the furniture item	✓	✓	x	✓	✓	✓	✓	✓	✓	✓	✓
Cart management	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Payment management	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Reports management	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Features of 3D object visualization											
Plane surface detection (Horizontal & Vertical)	✓		x	✓	poor	✓	✓	✓	✓	✓	low
Furniture model rotation	✓	✓	x	✓	✓	✓	mid	✓	✓	mid	mid
Light Estimation	✓	✓	x	low	✓	mid	✓	✓	✓	low	
Recognize the gesture movements	✓	x	x	✓	✓	✓	✓	✓	✓	✓	
Object tracking	✓	✓	x	✓	✓	✓	✓	✓	✓	✓	
Cloud Storage Support	✓	✓	x	low	✓	✓	✓	✓	✓	✓	
3D model scaling	✓	x	x	✓	mid	✓	✓	✓	✓	✓	
Model can swipe using the fingers	✓	✓	x	✓	poor	✓	✓	✓	✓	low	
Showing the 2D measurements	✓	x	x	low	poor	✓	low	✓	✓	low	
Non-Functional Requirements											
Ease of use	✓	✓	✓	✓	✓	mid	✓	✓	✓	low	low
Improve the customer expectation	✓	✓	✓	✓	poor	✓	✓	✓	✓	low	low
No need of much knowledge	✓	✓	x	✓	✓	✓	✓	✓	✓	✓	
Reduce unnecessary costs	✓	x	x	✓	✓	mid	✓	✓	✓	low	✓

Table 4. System Evaluation Results

8. Future Works

This research has thrown up many questions in need of further investigation. Further work needs to be done to establish whether furniture items match the interior architecture, match furniture products with the home types of equipment, and develop applications that make use of IOS clients.

9. Conclusion

Analysis of the evaluation of the results researcher shows that this system implementation will be more contributed mainly for the Sri Lankan furnishing industry as well as for the whole world. This application will enhance the marketing strategies of the furniture sellers and improves the customer satisfaction for engaging with online furniture shopping. Therefore, the furnished application works brilliantly in modern society where consumer convenience comes first. By utilizing AR, we can accomplish the objective of giving the real time preview of the system.

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Smart Wireless Forest Fire Alerting System

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Abstract: *The forest coverage over 30% of the Earth's land surface assist to balance the water cycle as well as the natural conversion of O2 and CO2, which aids in organism respiration. Therefore, various research and studies have been paid attention to prevention of deforestation. Deforestation is mostly caused by forest fires, which can occur naturally or as a result of human negligence. Since a forest fire can be started by a single lightning strike, preventing them before they start is deemed impossible. However, early discovery and response can lower the frequency of occurrence. The study proposes a Wireless Sensor Network with smart sensor concept, which uses radio frequency communication as the communication technique and allows sensor nodes to connect with each other to verify the status of their neighbors. The base station or master node of the sensor network, which is located outside the forest cover, has been used to send out alerts using GSM technology. The communication network was built up with the help of HC-12 and NRF 24L01+ radio frequency transceivers, and the DHT-11 temperature and humidity sensor were utilized for detection. The accuracy was tested through a different testing strategy with a prototype of a distributed single sink wireless sensor network, and the results were evaluated. A comprehensive system with more components can be developed to expand the sensor network to cover a large forest area.*

Keywords: *Forest Fire Detection and Alerting, Wireless Sensor Networks, Smart Sensors, Inter Sensor Communication, HC-12 Communication, NRF24L01+ Communication*

1. Introduction

According to the earth's mechanism, which was designed to persist, life has been constructed on trees, water, and air. These three factors work together to provide a healthy environment for all living beings on the earth. Trees are the most important of the three elements when it comes to maintaining the balance of the other two. Trees have a big impact on the water cycle and the composition of the atmosphere. Although the total area of the globe is 509 600 000 km^2, only 148 326 000 km^2 is land ("Earth Facts - Nations Online Project," n.d.). From this land area over 30% is covered with forests. Forests are also an important part in the natural conversion of CO_2 to oxygen, which is the respiratory gas of almost all living things. Forests not only keep the planet's living conditions alive, but they also shelter the most species on the planet.

In Sri Lanka, forests cover more than 29.9% of the land area. The island of Sri Lanka is home to a diverse range of animals and plants. Depending on the weather, there may be 50 to 200 fires reported in Sri Lanka each year("GLOBAL FOREST FIRE ASSESSMENT 1990-2000 - FRA WP 55," n.d.). Additionally, a single fire in Sri Lanka often affects an area of 10 acres. 20% percent of all reported fires are in eucalyptus plantations, and nearly 55% of all reported fires occurred in Pinus plantations. For comparison, even though most of the countries have taken various kinds of measure to detect and reduce the damage caused by the forest fires, Sri Lanka doesn't have a solution to this problem. Main reason for this one can be seen as the forest fires are neglected by not only public but also the authorities until it occurs and ends up with a huge damage to the forest cover and the biodiversity of Sri Lanka.

Forest fires can start in one of two ways: the natural way or the artificial way. The artificial method involves man-made conditions such as cigarette stubs, charcoal left behind from camping trips, and so on. The natural way is to spontaneously combust dry fuels like wood or dry leaves due to severe heat or a lightning strike. Even while the artificial way can be controlled by implementing strict laws, forest fires that occur spontaneously cannot be stopped. The only way to solve this problem is to detect them early and respond quickly to reduce the damage. Throughout the history of technology, people have invented a variety of solutions to this problem. Among these are satellite-based solutions, image processing approaches, and sensor-based solutions. As well as various forms of advantages, the disadvantages can also be recognized when revising them. The system aims to identify the methods used by the world to detect and alert the forest fires, identify the weakness of them and develop a novel and efficient system to mitigate. In order to achieve the above aim this paper proposes a system that uses Wireless Sensor Networks (WSNs), which are widely utilized in industrial automation

and large-scale agricultural fields, to detect and alarm forest fires early, and prevent the damage as soon as possible. The proposed system will be able to implement in anywhere in the world as it uses the radio frequency as the medium of communication where it can function alone even in a forest with no network coverages available and also power saving techniques have been used to maximize the efficiency with a new method added to have inter-sensor communication.

2. Literature Review

A. Types of Forest Fires and Detection Techniques

As mentioned earlier, when considered the forest fires all over the world, an origin of a fire can be named in to 2 categories as Naturally Occurred Fires and Man Made Fires. ("A Review on Forest Fire Detection Techniques - Ahmad A. A. Alkhatib, 2014," n.d.). Naturally occurred fires can be due to the extreme heat and the humidity conditions of the atmosphere which eventually begin to burn the dry leaves, twigs, lichens etc. Also, spontaneous strike of a lightning on to a dry tree or a log can give a head start to a forest fire. Man-made fires are due to the carelessness of the humankind when doing activities inside the forests. A burning trash of a cigarette, leftovers of a campfire which was not properly terminated are the common reasons for man-made fires. In countries like Sri Lanka, traditional farmers set fires to the part of a jungle to setup the land for their chena cultivations. These fires also can be spread through the forest and make a huge fire. Through this literature review, it was able to identify the earlier applied techniques and methodologies by other researchers to implement similar systems and advantages and drawbacks of them. According to the types of forest conditions the forest fires are categorized as Creeping fires, Crown fires and Ground fires(Drapalyuk et al., 2019).

Fire suppression is a difficult task as it spread in large areas within minutes. There is a known rule by fire fighters on suppression of forest fires: "1 minute – 1 cup of water, 2 minutes – 100 liters and 10 minutes 1000 liters"("A Review on Forest Fire Detection Techniques - Ahmad A. A. Alkhatib, 2014," n.d.). The first step of an effective fire suppression is to detect as soon as possible and alert the authorities. Most common fire suppression and detection techniques used by the authorities can be identifies as, controlling burning of a forest layer, fire weather forecasting and estimation of fuel and moisture, watch towers inside forest, optical smoke detection, lightning detectors by which the coordinates of the strike can be detected, infrared, spotter planes, water tankers, educating house owners through Fire Watch or similar schemes("A Review on Forest Fire Detection Techniques - Ahmad A. A. Alkhatib, 2014," n.d.).

With the evolution of the technology, the world identified the importance of forests and the importance of the reducing the damages of forest fires, the world began to search for new methods to detect and alert on forest fires.

B. Satellite based Systems

The satellites orbiting around tasked to observe and detect forest fires. Advanced Very High Resolution Radiometer (AVHRR) ("USGS EROS Archive - Advanced Very High Resolution Radiometer (AVHRR) - Sensor Characteristics | U.S. Geological Survey," n.d.), which launched in 1998 and Moderate Resolution Imaging Spectroradiometer (MODIS) ("MODIS Web," n.d.), which launched in 1999 are been used. The drawbacks of these are, they can provide the images of the regions Earth with a 2-day time interval and the resolution of the images can vary with the weather conditions ("A framework for use of wireless sensor networks in forest fire detection and monitoring," n.d.). Forest Survey of India under the ministry of Environment, Forest and Climate Change is using a satellite-based system using MODIS as Forest Fire Alert System 3.0 since 2017("Forest Fire Alerts System 3.0 | Forest Survey of India," n.d.) . Registered users will alert on the forest fires via SMS with the geo location of the fire and a weblink to open via browser.

Other than those, any geostationary (GEO) and Low Earth Orbit (LEO) satellite can be used. The optical and infrared radiations emitted by burning flames has to identified as early as possible by those satellites and should send back to Earth to alert authorities. LEO and GEO satellites are orbiting over 22,800 miles above the10 planet's surface. So, the intensity of radiation decreased. Also, a satellite is sent to perform various tasks like communication, remote sensing etc. A dedicated satellite for forest fire detection cannot be defined as a cost-effective method. So, they might not be equipped with all the relevant technical requirements like transponders, amplification receptions, antennas, a dedicated downlink transmission for forest fire detections etc ("A Review on Forest Fire Detection Techniques - Ahmad A. A. Alkhatib, 2014," n.d.).

C. Optical Sensor and Digital Camera

Present, two types of sensor networks are available for the forest fire detection. Wireless Sensor Networks and Camera Surveillance Networks. Development of the technology have given the world high performance hardware products like sensors, digital cameras, thermal imaging etc. When it integrated with software capabilities like image processing techniques, it will provide optical automated systems for early detection of forest fires. According to National Forest Centre of Slovak republic, there are few sensors which can be used to develop such kind of optical sensor systems such as, Video-

camera, Thermal and Infrared camera, IR spectrometer and Light Detection and Ranging Systems. ("Detection and monitoring of forest fires.pdf," n.d.)

FireHawk is a risk management system used in South Africa to detect forest fires. This a camera-based system controlled by an operator. Cameras are placed on a tower which will cover around 6-7km of range ("FireHawk," n.d.).

AlarmEye is a fire detection system with self-learning algorithms. The system is specially designed to detect forest fires with monochrome, IR, color, multi frequency sensors. Effective distance my differ with the selected camera. The system is implemented in Thailand ("Detection and monitoring of forest fires.pdf," n.d.)

Nayana G H (G. H, 2018) proposed a system using color models to detect the forest fires. The images taken from digital camera are analyzed through matlab simulations and detect the fires. For this also it needs to be a clear image of a fire and also a large area should be covered with fire to detect using the software algorithms. Motions of the sun, moving clouds, shadows of trees also obstruct the sight of the cameras and may give errors. Also, the tower with these systems has to be located on a top of a hill in order to cover a maximum area of land. Hence forests with flat terrains and rich canopies will not provide effective results with these optical sensor towers. When integrated with image processing techniques also, give some false alarms due to the weather conditions like mist, heavy rains.

D. Wireless Sensor Networks

Wireless Sensor Networks are mostly used in industrial automations in the world. The line of sight and the early detection of the fire can be achieved through this technology. The sensors will gather the environmental parameters and it will be sent to the master nodes using a wireless communication protocol. When setting up a WSN, communication networks, routing protocols, power management are key areas which needed to be considered. The components of a sensor node should be defined in the design, and it may differ from the type of task it has to achieve. Also, the scale of the sensor network may vary with the type of the area and the operations (Lewis, n.d.).

Aslan ("A framework for use of wireless sensor networks in forest fire detection and monitoring," n.d.) has proposed a fire detection framework using WSN with sensor deployment scheme, network architecture and intra cluster communication protocol. The architecture is based on finding the optimal distance between the sensor nodes to avoid collision and minimum number of sensors to maximize the coverage.

However proposed system does not state about the power resources and the wireless communication protocol to be used.

Wenning et al (Wenning et al., 2010) present a successful disaster detection routing technique using wireless sensor networks. The protocol was created to be aware of a destruction of a node. And it can change the pathways if a sensor node fails. The method can also change the routing state based on the data it receives. A potential failure danger indicated by an observable phenomenon. When implementing in the forests the source of power and the wireless communication protocol has to be considered carefully as both the resources are limited inside the forests.

There are few wireless communication standards used in wireless sensor networks such as IEEE 802.15.4 , ZigBee, Wireless HART, IEEE 802.15.3, ISA100.11a and Wibree. ("iceeot.2016.7755194.pdf - International Conference on Electrical, Electronics, and Optimization Techniques (ICEEOT) - 2016 Forest Disaster management | Course Hero," n.d.).

According to the study, the low cost and effective method of detecting and alerting forest fires can be defined as the use of Wireless17 Sensor Networks. The existing and the proposed systems also taken into consideration. In the next chapter we moved into the approaches based on Wireless Sensor Networks. And figure out the best approach to develop a system which can give a solution to the problem identified while fulfilling the objectives.

3. Design Framework and Methodology

The Smart Wireless Forest Fire Alerting System is based on Wireless Sensor Technology. The architecture of the proposed system consists of mainly 3 components.

- Sensor Node – The sensor node is responsible for taking the environmental parameters.
- Sink Node – Sink node takes the data from the sensor node and send it to the base station.
- Base Station - The base station sends the alerts to the authorities
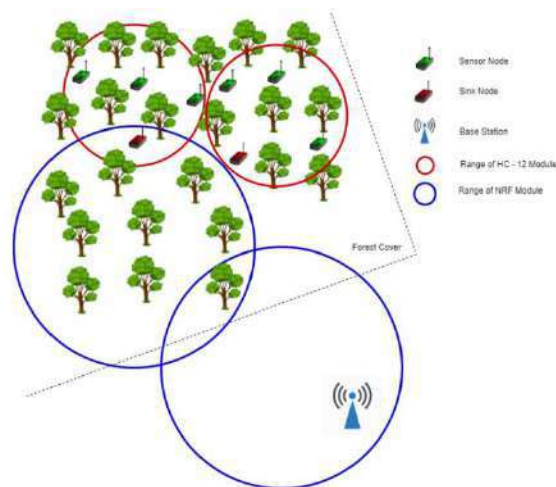
- *A. Proposed Architecture*

Figure 1: Proposed Architecture
Source: Author

The environment of the proposed system is forests. So, the harsh environment, power factor and the lack of communication coverage inside the forests has to be addressed when designing the system. Also, to acquire the scalability, distance of the components and the range of the communication protocols have to be decided. Inter sensor communication also should be taken into consideration.

The system will obey the basic rules of single sink distributed WSN. But because of the constraints in the theoretical approaches, the system will adapt the components in centralized formation technique also.

Usually, the sensor nodes will take the environmental parameters like temperature and humidity, it will send to the sink node to analyze. But, in proposed system sensor nodes are designed according to the smart sensor concept. Thus, inside the sensor node heat index will be calculated as increasing of the heat will not be accurate to detect fire. If the heat index is not exceeding the threshold level, sensor node will check for the status of the active. Else, the sensor node will alert the sink node on heat. And if the sensor node detects a failure of the neighbor node, it will also alert to the sink node. Sink nodes will get the analyzed data from the sensor nodes and send it to the base station. Base station which is placed outside the forest cover will send and SMS alert to the pre-defined authorities about the temperature increment.

According to the architecture of the proposed system, inputs and outputs will be specific to the component according to their role in the system. As the system is fully autonomous, all the inputs will be taken by each component itself. Sensor node will have two kinds of inputs. The main input to the system is the environmental temperature and humidity. Those will be taken from the temperature sensor which is integrated to the sensor node. The secondary input to the sensor node will be the signal from the neighbor node which will be received to check the status of the neighbor node. This will be received by the signal transceiver in the sensor node. Inputs to the sink node will be the two signals from sensor nodes on heat and the neighbor node failure. Both signals are acquired by the transceiver in the sink node. Inputs to the base station will be the signals from the sink node. Those are received by the long-range transceiver integrated in the base station.

The output of the system also differs with each component according to their role in the network. Sensor node will output the heat alert signal and neighbor node failure signal to the sink node. Sink node will output the two signals taken from sensor node to the base station. These signals will transmit one by one in different time intervals to avoid data loss. Output of the base station is the alert to the authorities through GSM technology. All the components in the system are designed to get the optimal power consumption as power is the critical resource inside the forest. All components are designed to get the power from solar panels separately.

B. Sensor Node

Sensor node is consisted with 2 components. Temperature sensor and the radio transceiver for the communication. Sensor nodes are made according to the smart sensor concept so the sensors will analyze the gathered data within the sensor, and it will decide what to be sent to the sink node for the alerting process. This will make the power consumption low. Taking the environmental parameters also done it time intervals. All the other times, the sensor is in idle state. Another feature of the sensor node is it will communicate with neighbor node to check the status of the node. Inter sensor communication has been establish in this system. If the neighbor node is in inactive stage, the sensor node will alert the sink node about the failure.

C. Sink Node

Sink node is act as the mediator between sensor node and the base station. It consisted with two transceivers. One will communicate with sink nodes and the other one will communicate with base station. This is done because of two reasons. As soon as a heat anomaly detected, the sensor node should send it to sink node and sink node should sent it to the base station. Because of this a transceiver will always in listening state. The other reason is the range of the transmission. Sink node will transmit the alert message to the base station which is outside the forest cover. This will need strong transmission power. So, a different frequency is used to do the communication.

D. Base Station

Base station is mainly responsible for sending a SMS to the authorities alerting the heat or the sensor failure. Sensor node and the sink node are placed inside the forest to take the environmental parameters. Since the forests do not have any network coverages, base station must be placed outside the forest cover where a network coverage is available. It will receive alert from the sink node and send the SMS to the relevant authorities via GSM technology.

E. Smart Sensor

This is the novel idea which has added to the system. As the radio frequency has used as the communication protocol in this system, there is not any method found to establish a sensor-to-sensor communication. Smart sensor means the sensor nodes will communicate with each other to check each other's status. This has achieved by exchanging signals through radio transceiver integrated in the node.

F. Development Methodology

1) Sensor Node: Sensor node was developed with DHT 11 sensor and HC – 12 radio frequency modules integrated to Arduino nano micro controller. Initially developed the circuit in bread board for the testing purposes before making a printed circuit board. Tx and Rx pins in the HC 12 modules also connected to the GPIO pins in the Arduino board. SoftwareSerial.h library is used in the coding to program the module. In the market, there are few HC radio frequency modules like HC 06, HC 05 and HC 12. The specialty of the HC 12 module is it has a SET pin. Using that pin the module can setup to different frequency channels to do the communication. This can be done within the code with AT commands. Checking the status of neighbor node will be done in a separate channel and when a sensor node has to communicate with sink node, sensor node will change the channel to the frequency channel which is used by sink node and sends the alert signal. DHT 11 was given a 5V and data pin was connected to the GPIO pins in Arduino board. Adafruit DHT.h library was used in programming the temperature and humidity sensor which will give the parameters to calculate the heat index. DHT – 11 will not measure extreme temperatures. So, when programming the sensor module, decided to take heat index as the variable data to get the threshold which will calculated with humidity.

$$at \ n \ \ x(\ \ ) = 1 + 2T + 3R + 4TR + 5T2 +$$

$$6R2 + 7T2R + 8TR2 + 9T2R2$$

2) Sink Node: Sink node is developed with two radio frequency modules namely HC 12 and NRF240L1+ module integrated to Arduino mega microcontroller. HC 12 will do the communication with the sensor nodes to get the alert. NRF module will send the alert signal to the base station which is outside the forest cover. Reliability, accuracy and efficiency is high for long range transmission with NRF module as it has few built-in features to enhance the performance and prevent data loss(Bento et al., 2019). Also, the ability to use 125 channels will give the system to scale easily. Same as the sensor node, SoftwareSerial.h library was used to do the programming in HC 12 module. Since NRF 24L01+ is a complex module 3 libraries have to use in addressing the module. SPI.h library handles the SPI communications and nRF24L01.h and RF24.h libraries to control the module. As soon as the sink node receives the alert using HC 12 module, NRF module will task to send the signal to the base station.

3) Base Station: The base station is placed outside the forest cover where it can have the mobile network coverage to send the alert via SMS. When doing the study, we considered on to implement the system in any forest cover. So, the main problem was lack of network coverages inside the forests. Because of this reason we have used 2.4 GHz radio frequency to do the communication inside the forests. System is automated so that without any human intervention, the system can run. Base station is the medium which the system connects with the outside world. Outside the forest cover a place where GSM coverage available has to be found to place the base station. Same as the sink node Arduino mega microcontroller was used to integrate NRF module and the GSM module.

4. Discussion

Everyone in Sri Lanka disregards the value of trees and their protection. Technology is rarely used to save forests. A vast amount of forest cover has been destroyed over the years as a result of forest fire negligence. To address this issue, a low-cost effective system for detecting and alerting forest fires has been proposed. The system was designed to produce a Smart Wireless Forest Fire Alerting System. The system was created using Wireless Sensor Network technology, allowing it to be implemented in any type of forest. The prototyped system is capable of covering more than 600 m2 of forest cover and is scalable as necessary.

The table below shows the test results obtained with range testing for each component separately. The tests were carried out in an open environment with trees and obstacles to simulate the environment found in forests. Started with the minimum distance specified in the specifications and ended when the signal failed.

Table 1: Range Test Results

Components	Distance	No. of Repetitions	Results (Number of successful nodes)	Percentage of Success
Two Sensor Nodes	1 m	10	10/10	100%
	10 m	10	10/10	100%
	50 m	10	10/10	100%
	100 m	10	8/10	80%
	500m	10	6/10	60%
	1 km	10	0/10	0%
Sensor Node and Sink Node	1 m	10	10/10	100%
	10 m	10	10/10	100%
	50 m	10	10/10	100%
	100 m	10	8/10	80%
	500m	10	6/10	60%
	1 km	10	0/10	0%
Sink Node and Base Station	2 m	10	10/10	100%
	50 m	10	10/10	100%
	100m	10	10/10	100%
	500m	10	10/10	100%
	1km	10	10/10	100%
	1.2 km	10	8/10	80%
	1.5 km	10	0/10	0%

Source: Author

Sensor to sensor range and the sensor node to sink node range give the same results as the same HC 12 modules were used. According to results the HC – 12 module is had issue when the transmission distance is greater than 50m. The Success rate is gradually decreasing and comes to zero at 1 km distance. So, by considering these results the maximum effective distance to place the sensor nodes and sink nodes can be decide as 50m. The placement of the sensor nodes can be explained as in the vertices of a regular polygon where the length of an edge is 50m and the sink node in the center.
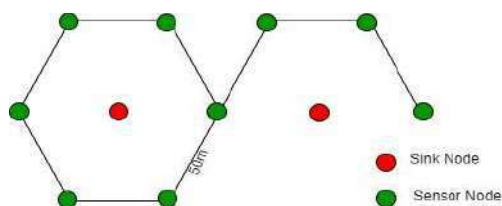
Figure 2: Ideal Sensor Placement
Source: Author

In the other scenario, the NRF module exhibits significantly greater transmission strength due to its Power Amplifier and Low Noise Amplifier features. It can successfully transmit over a distance of 1km. According to these results, the Sink node and the Base station should be placed as their ranges get intersected. In order to check the accuracy of the temperature measurements of the DHT 11 sensor, few types of fires according to the magnitude were introduced to the sensor and recorded the maximum distance where it stops the detection of the fire and increase the temperature up to 45°C. The

maximum body temperature a human body can withstand is 42.2°C("Thieme Medical Publishers - What can a person survive? The borders of the human body," n.d.). 4 types of fires were introduced to do the test:

- Flame – A candle flame
- Small Fire – Fire made by burning of papers.
- Medium Fire – Burning of household trash
- Large Fire – A fire made using a pile of dry woods (To simulate a small campfire)

Other than a large fire mentioned in this cannot be made in an urban environment. By analyzing the results how the sensor is responding to the above fires we can predict the results to a fire than a large fire. Here the distance was rounded off to the nearest meter.

Table 2: Accuracy Test Results

Type of Fire	Repetitions of testing	Average Distance where the detection ends
Flame	10	1-2m
Small Fire	10	3-5m
Medium Fire	10	6-10m
Large Fire	10	10-15m

Source: Author

According to the results of this test, we can decide a fire larger than a small campfire made with pile of dry wood, will detect before 10m to the sensor node. To test the system's response rate, the time between exceeding the temperature threshold and receiving the SMS alert was measured. All of the above-mentioned fires were also used in this test, and all of the components were placed within the effective distances taken in range testing. The average time it took to receive the SMS after exceeding the temperature threshold was around 4.5 seconds. Based on the results of this testing, the proposed system's prototype can be implemented in a real-world scenario to detect and alert forest fires. Using the table 2 calculations, this prototype with two sensor nodes can cover more than 600 m2 of forest cover.

5. Conclusion and Future Works

In Sri Lanka, everyone is neglected the value of trees and protecting of the trees. The technology is hardly used in saving of forests. In the world, they always tried with their maximum to protect forests from forest fires. Even the foreign governments funding for the research regarding forest fire alerting systems. Vast amount of forest cover has been destroyed due to the negligence of forest fires throughout the years. To give a solution to this problem, the paper has proposed a low-cost effective system to detect and alert forest

fires in Sri Lanka. This study has focused on developing a Smart Wireless Forest Fire Alerting System. The system was developed in Wireless Sensor Network technology providing the ability to implement in any kind of forests. The prototyped system can cover more than 600 m2 forest cover and the system is scalable as needed. The limitations of this system are as only two sensor nodes were developed as the prototype, the coverage area is low, Base station has to be placed where a GSM coverage is available, Signal interferences may occur due to the animal behaviors inside the forests and once a node alert received, human resources should be available for maintenance. This system can be further improved with the technological enhancements such as adding the GPS sensor to the node to give the location, using machine learning technologies to analyze and predict the fires, and Beacon signal can send to air observers on the origin of the fires.

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Towards an IoT based Vehicle Management System for Vehicle Tracking & Vehicle Diagnostics with OBD2 telematics

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Abstract: In a fleet of vehicles, concern about each vehicle is mandatory. A Vehicle Management System (VMS) is primarily used to manage the vehicles' details and track the details of the vehicles. The importance of vehicle tracking and diagnostics must be stressed as other fleet management features also depend on them. Most fleet management systems depend only on vehicle location tracking using Global Positioning System (GPS) technology to manage the fleet's data. Through this proposed system, it aims to combine the vehicles' tracking details and diagnostic details for doing fleet management remotely by minimizing human resources. According to the reviewed systems, On-Board Diagnostics (OBD) has been identified as a reliable automotive technology that needs to track the performance inside the vehicle and regulate the performance. The proposed system has both a tracking device and an ELM327 Bluetooth OBD scanner in order to receive coordinates of the vehicle's location and vehicle diagnostics, respectively. This paper signifies the use of the Internet of Things (IoT) to accomplish the remote access of vehicles' data. For vehicle data to be sent to the cloud, GSM technology is required to send the vehicle's data to the cloud server for remote monitoring. As a cloud server, it uses a Message Queuing Telemetry Transport (MQTT) broker. The Arduino sensor data is lightweight and therefore uses the messaging protocol for the IoT for data transmission by connecting the devices to the internet. The proposed system incorporates the most advantageous technologies and devices for fleet management.

Keywords: Fleet Management, IoT, OBD, GPS, MQTT, ECU, Remote monitoring, Telematics

1. Introduction

Remote fleet management is addressed in the transportation sector unless there is no way to reliably monitor the required details of vehicles in real time. Determining the vehicle's conditions, calculating the instant fuel consumption, predicting the maintenance periods, etc. have to be more concerned because most fleet owners assume that doing predictions and determining the vehicles' conditions may be difficult in real time monitoring. As a result, most users still use traditional methods in vehicle management, such as manually recording data on each vehicle, manually calculating expenses, and relying on a mechanic to always have an idea about a vehicle, among

other things. So that led to delaying the upliftment of the fleet management area. When considering existing systems, most of the vehicle management systems depend only on GPS technology to track the vehicle's position. According to the reviewed systems, it can be identified that for vehicle tracking it uses both mobile phones as well as telematics devices by embedding GPS. But installing a mobile phone inside a vehicle or using the driver's mobile phone's location to track the vehicle is not always the best way to track the vehicles in a fleet. There are telematics devices available as off-the-shelf devices, but most of the devices are highly expensive. Due to the high cost of telematics devices and the payable amount for the web application, it has also reduced the usage of the telematics devices in fleet management.

Major part of the transportation depends on fleets and buses, therefore the money allocated for that should be managed with minimal human resources (Mahaveer Penna, 2017). By considering the importance of fleet management and issues in the existing systems, it is easy to introduce a new system with a telematics device at low cost and dedicated software that can be used to keep track of vehicles and give the ability of remote accessing of vehicles' information with the use of the Internet of Things (IoT). Using this proposed system, fleet owners can always stay in touch with their fleets by knowing real-time information, including the history of each vehicle in their fleet. To collect the vehicles' data, it is using GPS for vehicle's location tracking and on-board diagnostics for vehicle diagnostics. Each vehicle uses Electronic Control Units (ECUs) to collect data, and from that data it can determine the vehicle and driver behaviour, environment, and be able to control the functionalities of the vehicle (Lotfi ben Othmane, 2018). ECU sensor data is collected from the ELM327 scanner by connecting it to the OBD II port, which is available in vehicles manufactured after 1996 as the on-board diagnostic system is a standard which was developed in the United States of America (USA) in 1996 and the OBD II port has been utilized in vehicles for diagnostic purposes (Reza Malekian, 2017). In the next sections of this paper, it discusses the technologies and features in reviewed systems, the architecture of the proposed system, including the specificity of each technology, and elucidates some of the results by discussing them appropriately. In this paper, we summarize the findings and new concepts to resolve the issues in

existing systems and present future work that may be essential for building a good vehicle management system with cost-effective components.

2. Related Work

Vehicle-to-vehicle communication is done for the clearance of lanes in an emergency (Mallikarjuna Gowda, C.P., 2017). The vehicle that has an emergency sends a notification to the other nearest vehicles to clear the path. The cooling system of the vehicle is activated at high temperatures sensed by the attached temperature sensor in the vehicle. The GPS module calculates the speed of the vehicle, distance travelled, and the location of the vehicle. If the vehicle's speed is greater than the threshold value, then an alert is given to the driver. Proximity sensors, which are attached to the rear end of the vehicle, are used to measure the distance to the obstacle when reversing the vehicle, and if the obstacle is very close to the rear side, then a buzzer beeps to alert the vehicle driver. The real-time data is also displayed on a liquid crystal display to be viewed by the driver.

A solution to economic loss in fleet management is resolved by introducing a secure, reliable system for fleet organizations to gain remote control over their fleet using IoT (Mahaveer Penna, 2017). There is a fuel level sensor to monitor the fuel level and, along with the GPS based odometer connected to the system, to determine the travelled distance by the vehicle at an instance. The authors have stated that a GPS-based odometer which is connected to the Arduino board can generate a pulse for each covered meter, and then, through that pulse reading, it can easily find the distance travelled by the vehicle at a particular instant. It has been mentioned that in the future they'll add RFID sensors for the driver's identification and, through that, willing to link the vehicle data with the driver, and an alcohol sensor will also be added for the safety of the driver and the vehicle.

A real-time fleet management and security system are built on a Linux-based embedded microprocessor (Channakeshava Gowda V.R., 2015). The in-vehicle system gathers GPS data and has a biometric fingerprint sensor for taking the authentication of the driver, a panic button to show a panic situation, a camera for grasping pictures in the vehicle, and a remote-controllable voice alarm for alerting. The GPS-634R GPS receiver module is fixed in the vehicle to take the location details along with the date, time, and ground level speed. A SIM 900 GSM or General Packet Radio Service (GPRS) interface is included to enable communication between the in-vehicle system and the base station server. GPRS Hypertext Transfer Protocol (HTTP) is used for the sending of vehicle data like driver id, longitude and latitude of the location, date, time, and speed transmitted to the remote server. If the GPRS connection gets lost, then the program will automatically recognize it and re-enable the network connection. As well as in an instance of fading GSM channels, the program has been written to store the data in an internal database and then later send the data like camera images to the server by File Transfer Protocol (FTP).

A prototype model has been designed for low-cost fleet monitoring (Lotfi ben Othmane, 2018). Each vehicle in the fleet is attached with sensors and ECUs to collect fleet data like speed, engine temperature, revolutions per minute (RPM), and location details. The Raspberry PI 3 uses PICAN2 for communicating between the vehicles' CAN-bus, OBD-II cables for having the connection of PICAN 2 to a vehicle's OBD-II, Adafruit Ultimate GPS to take the location details, and Hologram Nova is used for communication between the PI and the server over the cellular network. Through a Web-application, it can visualize the fleet management data. Python is used for the fleet data collection and the Raspbian Operating System (OS) is the OS used here. Node.js has been selected to run the fleet management service, and MongoDB is the database used.

A concept of an intelligent and sensor network system has been designed for vehicle maintenance and safety(Christo Ananth, 2014). The PIC16F8777A is the microcontroller used here, which is low in cost, gives power-saving operating modes and has code protection. The power supply, Radio Frequency (RF) receiver, speed control section in zones, engine cooling fan, buzzer unit, GSM module for SMS, vibration detection sensor, engine and temperature sensor are connected to the microcontroller. The engine temperature monitoring system, accident detection and intimation system, speed and control section, and RF transmission are the major modules which are hosted by the PIC 16F877A. Through this proposed system, it can automatically send the various parameters like temperature of the engine, speed, etc. and send the records in case of any emergency or accident.

A system proposed for the military environment, to do predictive maintenance based on information given by on-board diagnostics and proactive maintenance based on both diagnostic signals from CAN-bus and statistical methods (Jan Mazal, 2020). European standard in OBDII supports for determine the controlling in exhaust such as lambda probes, fuel and air intake system's conditions like fuel injection pressure, ignition advance, intake air temperature, intake air quality etc., and standard input operational data like vehicle speed, engine speed, coolant temperature and oils etc. are also taken. Monitoring braking systems, monitoring safety systems like garbage, etc., monitoring transmissions, state of the brake pads, state of the brake fluid, and condition of the spark plugs, monitoring active chassis and monitoring the quality of motor oil are some characteristics parameters of the proposed system.

This study was done to identify the suitable technologies and to add features to the proposed system by comparing the best of them in referred systems. Table 1 summarizes the communication technologies, data processor types, and data storage methods identified in the referred systems. According to the summarized data in Table 1, Bluetooth has been included in existing systems to fulfill certain tasks. Vehicles that are equipped with GPS are beneficial in locating the vehicle's position (Kai, 2020). OBD is responsible for monitoring the vehicle's engine parameters, transmission, and emissions control components (Srinivasan, 2018).

Table 1. Qualitative analysis of the reviewed VMSs

Reference work	Communication Techniques	Data Processor	Data Storage
(Mallikarjuna Gowda C P, 2017)	ZigBee protocols, GPS	Arduino Mega	-
(Mahaveer Penna, 2017)	GPS, IoT	Arduino Uno(ATMEGA328/P)	Cloud server
(Channakeshava Gowda V R, 2015)	GPS/GSM.,GPRS HTTP, FTP	Cubietruck	GUI server
(Lotfi ben Othmane, 2018)	GPS, IoT, ECUs, PICAN2 Hologram Nova-2G/3G	Raspberry Pi 3	Remote service
(Christo Ananth, 2014)	GSM	PIC 16F877A	-
(Jan Mazal, 2020)	Bluetooth, GPS, ECUs CAN bus protocol SAE J1939	OBD(have microcontroller based processing system)	CANcase log device
(Srinivasan, 2018)	BLE,4G WIFI dongle, GPS	Raspberry Pi 3, OBD-II	Cloud server
(Dhanalakshmi, 2017).	GSM, Ethernet ,GPS/GPRS	Arduino UNO ATMEGA 328p	Web server

Table 2. Analysis of frequently used techniques for VMSs based on specificity

Technique	Use for	(Mallikarjuna Gowda C P, 2017)	(Mahaveer Penna, 2017)	(Channakeshava Gowda V R, 2015)	(Lotfi ben Othmane, 2018)	(Christo Ananth, 2014)	(Jan Mazal, 2020)	(Srinivasan, 2018)	(Dhanalakshmi, 2017)	(Garba Suleiman, 2018)
GPS	Location Tracking	✓		✓	✓			✓	✓	✓
	Calculate the distance	✓	✓							
	Vehicle's speed calculation	✓		✓				✓		
OBD	Collect ECU's data				✓		✓	✓		
	Gain vehicle's speed				✓		✓			
GPRS/GSM	Connect to the Internet			✓						
	Send SMS					✓				✓
External sensors	Sense the vehicle parameters	✓	✓	✓		✓		✓		

The Arduino or Raspberry Pi boards are generally used to read and process data and send it to a server or else use another service as a data storage method. As shown in Table 2, the specificity of GPS and OBD depends on purpose of what those techniques are used for. If it is taken, a system proposed by Lotfi ben Othmane, (2018), both GPS and OBD data are combined, and the vehicle's speed is taken from the OBD data by manifesting the accuracy of OBD data. The calculated distance travelled throughout a trip is calculated by GPS data and is also applicable in existing systems. In most of the reviewed systems, they use the external sensors to measure some of the vehicles' parameters like fuel consumption, coolant temperature, etc. In the next section of this paper, it suggests a more reliable way to use GPS and OBD by reducing the overall cost of having a good VMS.

A. The Proposed System

The proposed system consists mainly of a telematics device, an ELM327 Bluetooth OBD scanner, and a web application. Live vehicles' data and history are visible through a web application for vehicle owners. Variations of OBD parameters can be seen on live charts. Live location displays on a Google map. The trip details like distance travelled, time taken, fuel consumption and abnormal OBD readings etc. are stored in the database and alert the malfunctions and maintenance through the web application based on the unusual OBD readings , Diagnostic Trouble Codes (DTC)s and mileage.

B. Architecture

The architecture of the IoT-based vehicle management system is shown in Figure 1. The system consists of a web application developed using MEAN (MongoDB, Express.js, Angular, Node.js) stack technology which provides real-time and past details of the vehicles for the fleet owners; a telematics device to receive the vehicle data and send those data to the server using 2G or 3G technology with the help of a GSM SIM 900 module; and an OBD device, which is also a sub part of the system which needs to gain the diagnostic details. The GSM SIM900 module, GPS module, and HC-05 Bluetooth module are connected to the Arduino mega in the telematics device. 12 V is supplied to the GPRS module, and a 5V DC to DC voltage regulator is used to take the power to the Arduino mega

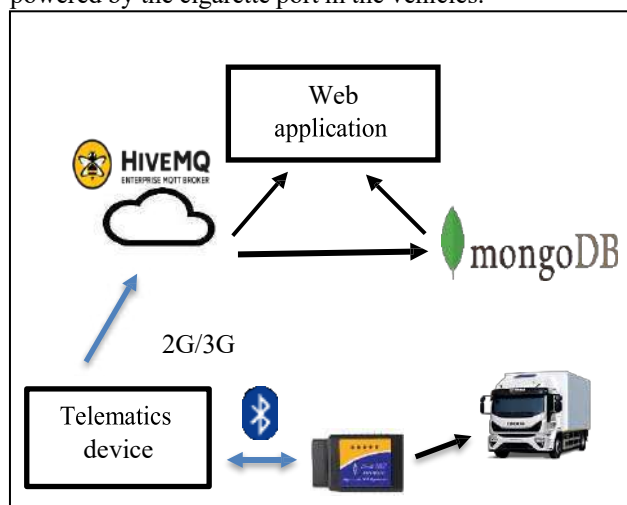board. Altogether, it forms a telematic device which can be powered by the cigarette port in the vehicles.

Figure 1. Architecture of the proposed system

C. OBD Scanner and On-Board Diagnostics

OBD is a standard tool that allows a person to check a car's engine status by plugging the OBD scanner into the port that has a 16-pin in it, and the port can be found under the steering wheel (J V Moniaga, 2017). The status of the vehicles can be obtained from diagnostic parameters like emission control, driving speed, battery voltage, engine coolant temperature, MAF rate, and more information from ECU. OBD-I has been replaced by the current OBD system, OBD-II. (Hussein Ali Ameen, 2021). OBD II uses Diagnostic Trouble Codes (DTCs) and Parameter Identifiers (PIDs) to diagnose malfunctions in a vehicle's subsystems. PIDs, which are hexadecimal values, are used to measure real-time parameters. Bluetooth and Wi-Fi adapters are available for low cost in the market. For this proposed system, it has chosen the ELM 327 Bluetooth scanner by considering the ease of retrieving data.

Figure 2. ELM 327 Bluetooth Scanner

A scanning tool sends a message having a hexadecimal code to request information from the ECU associated with a specific parameter, which is defined by the SAE J1979 standard, and there are five OBD-II signalling protocols called SAE J1850 (VPW and PWM), ISO 15765, ISO 1941-2, and IS0 142300-4 used to interpret the message (Reza Malekian, 2017). The ECU finally sends back a hexadecimal code in response. The actual measurement is obtained by converting the hexadecimal value to a decimal value or by doing calculations.

D. Technologies

The technologies used in this project are selected by considering the optimum advantage of each one individually to fulfill the requirements of the system. GPS technology is usually needed for location tracking. By using a GPS module, the latitude, longitude, and time of the current location of the vehicle will be grasped and sent to the server. A Map API is required to visualize the GPS coordinates on a map. The Google Map API and Mapbox API are well-known map APIs which offer the service for tracking using maps and related features. In this project, it is using Google Map API as it is easy to include maps to the web application and provide benefits to the users reliably.

In the automotive field, on-board diagnostics is essential for vehicle emission diagnostics and malfunction diagnostics. There are dedicated sensors to send electrical signals as feedback to the vehicle's main ECU (Tamer Abukhalil, 2019). OBD-II is the latest technology in OBD systems and the Controller Area Network (CAN) bus connects the ECUs inside the vehicle to consecutively monitor the running condition of the vehicle (Jheng-Syu Jhou, 2013). The ELM327 Bluetooth OBD-II is used for sending the OBD data to the microcontroller board in a telematics device by connecting a HC-05 Bluetooth module to the microcontroller board. OBD data and GPS data are very small in size. Therefore, there is no need to use a high-microprocessing-power microcontroller to read and process the data (Chetan S. Patel(M.Tech), 2020). In this proposed system, it is using an Arduino Mega, which has sufficient software serial pins and hardware serial pins to connect other modules. For communication purposes, it has chosen the GSM SIM 900 module to get a 2G or 3G internet connection to send the vehicle data to the cloud server. GSM technology is more reliable and low-cost for use by the number of vehicles in a fleet. IoT devices mostly use the MQTT protocol to send the sensor data to a server or in an instance of device-to-device communication. This system makes use of the HIVEMQ cloud public broker, which can be tested for free and can be used in the future as a private cloud MQTT broker to send encrypted messages in a more secure manner. The MQTT broker acts as the cloud server, and the vehicle data is sent to the cloud server for real-time monitoring purposes and for future usage of data. Data is sent to the MongoDB Atlas, which is a cloud-based database. As MongoDB is used, as it is a NoSQL database, which gives the flexibility of handling the data of a fleet, and there is no restriction on the variety of data that is stored in the database.

E. Web application.

The MEAN stack is used for web application design, providing powerful application by NodeJS backend, angular framework handling by JavaScript or Typescript as a frontend language, MongoDB as a no SQL database, and Express.js, which manages routes and servers. Figure 3 shows the home page, which displays the vehicle asset number on the left side, and on the right side it displays the vehicle's details, which is searched by asset number.
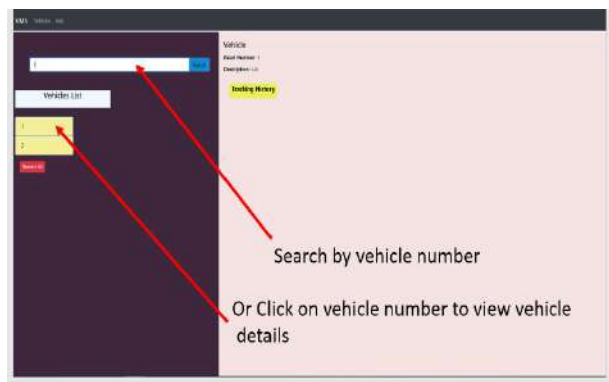
Figure 3. Home page of Web Application

If the user wants to track the tracking history of the vehicle, they can click the yellow-colored tracking history button on the right side of the home page. In addition to these, add a new vehicle, update the vehicle's details, real-time monitoring of variations of OBD parameters, real-time vehicle location viewing, and past diagnostics and tracking data can be viewed through the web application.

F. Database and MQTT Broker

As the name suggests, the Message Queuing Telemetry Transport (MQTT) protocol can be used for telemetry applications, which is a lightweight, open messaging protocol used for communications among IoT related devices. In the MQTT protocol, there is a broker(server) that contains "topics. Topics are the way to determine who receives the data generated by a sender (Jay Lohokare, 2017). The vehicle data is published in real time by Arduino devices via 2G/3G connection to the subscribed topic of the HIVEMQ broker, which is a public MQTT broker used to test the demonstration process. As in Figure 5 the published data to the broker can be viewed through the MQTT lens, which can be installed as an extension in Google Chrome.
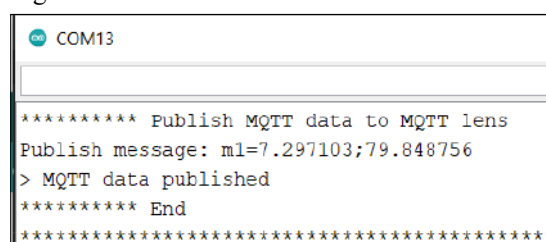
Figure 4. Serial monitor reading of publishing the GPS coordinates to MQTT broker

Figure 5. Test the publication of data through MQTT Lens

MongoDB is a document-oriented database system, classified as a NoSQL database system, and the data is stored in a document format with a structure like JSON

documents (Choopan Rattanapoka, 2019). As shown in Figure 6, The vehicles' data published to the broker/server is sent to the MongoDB Atlas for future usage and to do analysis about vehicles in the fleet.

Figure 6. Recorded GPS data in MongoDB Atlas

3. Results and Discussion

The Google Maps API provides clear and accurate maps to view a certain asset's location. Figure 7 shows the location of a vehicle at a certain position. The stored coordinates are taken from the MongoDB and displayed using Google Maps in the web application. Live location can be monitored through the web application by retrieving the live GPS data directly from the server. At the same time, the trip details like distance travelled , average speed, and overall time for the trip are stored in the database.

Figure 7. GPS coordinates displayed using google maps

To monitor the vehicle's diagnostics details, it should connect the OBD device to the OBD port in the vehicle. If it connects well and receives power from the vehicle, then the red light in the scanner is lit up and remains constant. Then connect the OBD scanner with the HC-05 Bluetooth module by pairing it using the Bluetooth Media Access Control (MAC) address of the ELM 327 OBD device. The MAC address of the OBD device used in this project is 00:1D:A5:01:0D:1C. These addresses can be found using AT commands, and AT commands are needed for pairing the Bluetooth devices. After connecting with the Bluetooth, the OBD readings are received only after the ignition key of the vehicle. When the OBD scanner starts to connect with the vehicle CAN Bus network by connecting to the ECUs, the green lights of the ELM327 scanner blink automatically and remain blinking when requesting OBD data by sending the PIDs. The below code part is written for the purpose of reading vehicle rpm, and Figure 8 shows some OBD parameters displayed in the serial monitor after sending the PID commands. There are different PIDs to read the OBD parameters, and in this project, it is using the ARDuino library, which already has predefined OBD PIDs as understandable functions. The OBD data can be easily accessed by calling functions such as ex, rpm ().

float tempRPM = myELM327.rpm();

```
if (myELM327.nb_rx_state == ELM_SUCCESS)
{
  rpm = (uint32_t)tempRPM;
  Serial.print("RPM: "); Serial.println(rpm);
}
else if (myELM327.nb_rx_state !=
ELM_GETTING_MSG)
  myELM327.printError();
```
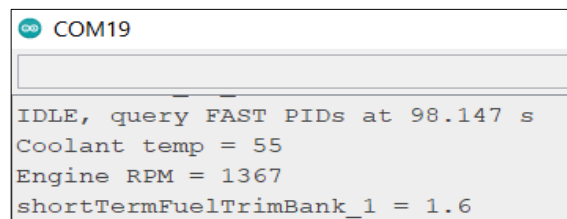
```
COM19

IDLE, query FAST PIDs at 98.147 s
Coolant temp = 55
Engine RPM = 1367
shortTermFuelTrimBank_1 = 1.6
```

Figure 8. Sample OBD parameter readings viewed in serial monitor.

Table 3. OBD readings of vehicles

OBD parameter	Suzuki van	KDH van	Wagon R car	Toyota Allion car	Vezel car
Throttle (%)	16.9	-	17.25	-	16.86
MafRate (g/s)	-	-	3.39	-	4.32
Intake AirTemp (^{0}C)	-30.80	-40	-40	-40	35
Mph	0	-	3.73	-	-
Kph	1.8	-	6	-	-
Engine speed (rpm)	0	-	1117.25	-	1000
LongTermFuel TrimBank_2 (%)	-100	-100	-	-100	-
ShortTermFuel TrimBank_2 (%)	-	-100	-	-100	-
LongTermFuel TrimBank_1 (%)	-100	-100	3.91	-100	-
ShortTermFuel TrimBank_1 (%)	-	-100	-5.47	-100	-
EngineCoolant Temp (^{0}C)	-40.35	-40	51	-40	33
EngineLoad %	-	-	40.39	-	68
FuelSystem Status	-	-	512	-	-
FreezeDTC	-	-	-	-	-
Battery voltage (V)	11.9	12.24	13.70	13.80	11.94

Table 3 shows the readings taken from several models of vehicles at a certain instant. According to the data in Table 3, it shows that not all PIDs support all types of vehicles. But each sensor reading is responsible for giving the current status of the vehicle, which is essential in determining the malfunctions of the subsystems in the vehicle. In further research on this project, the necessity of estimating the vehicle's performance remotely will be addressed using live OBD readings displayed via the web application and the OBD data recorded in the database to know the abnormal readings. Then the alerts are displayed in the web application if the OBD parameter reading increases or decreases more than the normal range of values for a certain OBD parameter. Some models of vehicles that have been manufactured lately support many PIDs, so the calculation of the fuel consumption can also be applied by using some OBD parameters like Mass Air Flow (MAF) reading, intake manifold pressure, rpm, etc. Using equation 1, one can find the fuel consumption of a certain vehicle. Fuel flow and vehicle speed are measured in litres per hour (l/h) and in kilometres per hour (km/h) respectively to obtain the fuel consumption in litres per kilometre (l/km) (Reza Malekian, 2017).

$$F\ e\ (C \qquad i\quad)[\ \frac{1}{\quad}\ ] = \frac{Fu\ F\ w\ [\ ]}{[\frac{1}{100}]} \times 100 \quad \text{(eq 1)}$$

From current fuel flow and the current vehicle speed, instantaneous fuel consumption is calculated when the vehicle is moving and the engine is operating (Hu Jie, 2010).

$$I \quad a\ .\ F\ e\ C \quad \div [^{\ 1}\ ] \frac{Fu\ F\ w\ [\ ]}{[\ ]} \qquad \text{(eq 2)}$$

If MAF PID is available, then fuel flow can be calculated as below (Samuel Shaw, 2019), (Reza Malekian, 2017).

$$F\ e\ F\ w[\ ] = \frac{MAF}{AF\ \times FD} \times 3600 \qquad \text{(eq 3)}$$

Where MAF is the Mass Air Flow in g/s, AFR is the Air to Fuel Ratio, and Fuel Density is denoted in FD. If the MAF sensor is not available in some vehicles, then there are different methods to calculate the fuel flow. It can directly calculate fuel consumption using engine fuel rate and speed or as a function of absolute load, RPM, and engine displacement, or it can be used to calculate fuel flow with intake manifold pressure, intake air temperature, RPM, and engine displacement (Hu Jie, 2010).

4. Conclusion

This proposed system is targeted to automate vehicle management to a certain extent with cost-effective and reliable methodologies utilizing IoT. The existing systems use GPS for vehicle tracking and OBD for vehicle diagnostics purposes. But it seems that there are no proper implementations of a VMS with the integration of GPS and OBD technologies. Therefore, the proposed system can resolve many issues in existing systems by allowing real-

time monitoring of tracking and diagnostics data with the combination of GPS and OBD technologies. It reduces the additional cost of fixing external senses to determine fuel consumption, coolant temperature, vehicle speed, etc. A complete system for fleet management can be built using GPS and OBD integration by fulfilling the features like vehicle tracking, vehicle health monitoring, and predicting maintenance with the use of data like the distance covered calibration through GPS data and diagnostics data taken from OBD. Bluetooth technology has been chosen for data transmission to the microcontroller by the ELM327 Bluetooth scanner because of its easy accessibility and cost effectiveness compared to using wired OBD devices. GSM is used in most systems to send SMS in an immediate instant, but in this proposed system, GSM is used for connecting the devices to the internet via 2G or 3G to send the data to the cloud server using the MQTT protocol. Using Wi-Fi or Ethernet devices inside a vehicle is an unnecessary cost as GSM technology is sufficient to send the sensor data to a cloud server. According to the referred technologies for building the web application and backend side, the Angular framework based on MEAN stack technology was selected as the appropriate one for analysis of telematics data. Therefore, it can be concluded that the issues recognized in existing systems will be resolved through the proposed system, which consists of the most suitable technologies, components, and methodologies for data retrieval and transmission.

5. Future Works

There is some other future work to be done and evaluated, such as keeping records on trips like distance travelled, travelled path, and started and ended times of a trip, which are important in determining a vehicle's travelled history. The fuel consumption needs to be calculated from OBD readings and displayed in a web application to have a clear idea about the fuel consumption according to the distance travelled and predict the vehicle maintenance according to the diagnostics details. Other things discussed in this paper are also implemented, and the system will be distributed to a fleet in the future to evaluate its working procedure.

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Acknowledgment

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Simultaneous Detection of Covid-19 and Its Pneumonia using Multitask Learning

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Abstract: *With the rapid growth of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) or Covid-19 into a pandemic, quick and efficient alternative testing methods were needed. Although Viral Nucleic Acid tests are the primary and standard method of testing, the time-consuming process, and the lack of availability of test kits in certain areas have been problematic for the quick diagnosis of the disease. Therefore, using radiologic modalities such as chest X- rays and Computerized Tomography (CT) were studied due to their wider availability because of their usage in the diagnosis of other diseases. This research is based on chest X-rays and tests the usage of deep multitask convolutional neural networks (CNN) to detect both Covid-19 and Covid-19 related pneumonia conditions in a patient simultaneously. Usage of chest X-rays allows for wider availability for usage in rural areas, where computerized tomography facilities are rare. Current results from separate custom CNN models with same layer structure but different task specific features, give an accuracy of 94% on Covid-19 detection and 90% accuracy on Covid-19 pneumonia detection. As a novelty, this paper suggests that a multitask learning based CNN model in the same architecture would be viable to detect both conditions from a single neural network, simultaneously. The simultaneous detection of Covid-19 and Covid-19 pneumonia in a patient is a further extension to traditional testing methods and allows for more effective treatments from the beginning.*

1. Introduction

In the history of the world known to humankind, there have been large number of infectious diseases that have gone on to become epidemics and pandemics. These infectious diseases are mostly disorders caused by micro living organisms, such as bacteria, viruses, fungi, or parasites. Some of these some have even been able to threaten the existence of humankind. Few examples for these can be given as the black death pandemic (1346-1353), which is claimed to have taken lives of over 50 million people (*Black Death - Effects and consequences of the Black Death | Britannica*), the flu pandemic (1918) caused by influenza (*History of 1918 Flu Pandemic |*

Pandemic Influenza (Flu) | CDC, 2019), which claimed lives of around 50 million people among many others.

The Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) or most known as Covid-19 disease is known to have started spreading in the Wuhan Province of the People's Republic of China. SARS-CoV-2 first became an epidemic and was mostly spread across the same province which it started from. The first confirmed case of this disease was reported in around December of 2019. But gradually it was spread to some of the most populous areas in China and then started to show cases in countries that were geographically far away from the place it started from. The number of infections started to rise day by day to the point that on 30th January 2020, The World Health Organization had to declare it as a "Public Health Emergency of International Concern" and declared the disease as a global pandemic on 11th March 2020. (*Coronavirus disease (COVID-19) pandemic | WHO*) As of the time of writing this, 513,396,993 cases have been reported and 6,261,084 deaths have happened worldwide because of Covid-19.(*COVID Live - Coronavirus Statistics - Worldometer*, no date) Up to now, there have been reports of five new variants with new mutations of the base virus. These new variants tend to have their own unique characteristics, basically on top of what the base virus had.

The common symptoms of Covid-19 include fever, cough, tiredness, sore throat, aches and pains, diarrhoea, loss of taste and smell etc. Serious symptoms may be difficulty in breathing, shortness of breath, chest pain, loss of speech or mobility. In the Covid-19 pneumonia, the lungs can be gradually filled with fluid and become inflamed, leading to breathing difficulties, which can become severe and could require oxygen supplies and ventilators. The Covid-19 pneumonia can cause additional symptoms such as increased heart rate and low blood pressure. These additional conditions are the ones that causes the severity of infections in patients with chronic diseases. This pneumonia variant tends to hold both lungs and is the main cause for the majority of Covid-19 deaths.(*COVID-19 Lung Damage*, 2022) Although this pneumonia does not often cause any

lasting lung damage depending on the severity of the infection. This can result in breathing difficulties, even after the disease has passed. To detect the Covid-19 pneumonia condition, additional testing needs to be done after a patient is detected positive for Covid-19. This requires additional time, which could be the time it needs to save another life.

There are two main categories that have been used clinically to detect the disease. They are Viral tests and antibody tests. Out of these two classes, viral tests have been the most reliable, accurate and widespread used. This category includes the rRT-PCR(Real -time reverse transcriptase-polymerase chain reaction test) which is the primary testing method that has been clinically used across the world and is the most accepted to determine whether a person is currently infected or not. In addition to this, rapid tests, which is also a sub-type of viral tests have been used to detect the disease in patients. Although not as accurate as the PCR test, these rapid tests can give results within a maximum time of 20 minutes, compared to 5-6 hours it takes with PCR.

With the high infection rate of the disease and the high number of patients and deaths, there was need of increased capacity for testing methods to detect and diagnose the disease. Sometimes, when running under full capacity, although the processing time is 5-6 hours for a PCR test, there were delays up to 2-3 days for results. This was because the available capacity for testing machines was not enough to keep up with the large input of specimens from collection centres. This led to further loss of lives that could've been otherwise saved if the results were available quickly and efficiently. Also, both above-mentioned testing methods require the supply of a test kit per patient and since there is a cost involved per each test. When mass testing, this became a problem especially for the nations which has low purchasing power like Sri Lanka. These countries had difficulties of baring the costs of the testing kits and had to compete with other countries to secure supply because the test kit production was lagging the demand. Ultimately, these costs had to be passed on to the patients and if multiple tests had to be done, which is common for an infected patient, the cost can add up. Also, all these testing methods could only detect if patient is positive with the Covid-19 virus. These cannot detect if the patient is in the Covid-19 pneumonia condition at the time of the detection of the disease.

Radiologic methods, such as Chest X-rays and CT scans were being used to diagnose various diseases for a long period of time. Therefore, it is beneficial to try to find ways to combine the knowledge on both artificial intelligence and radiologic methods to find efficient,

cost-effective, and less time-consuming methods to detect Covid-19 and Covid-19 related pneumonia conditions in suspected patients.

The aim of this research is to Build a Multitask Deep Convolutional Neural Network (MTDNN) based solution to simultaneously detect Covid-19 and Covid-19 related pneumonia in a single Chest X-ray image to enable quick, cost effective and more insightful diagnosis of Covid-19 patients. This will enable the patients to avoid delays in testing and reduce the cost per test. Further with the addition of simultaneous detection of Covid-19 pneumonia, more medical attention can be given from the beginning to the patients who requires.

This paper is structured as follows, Section 1 gives an introduction on to the research problem, section 2 gives a literature review on the related works. The following sections contain the methodology, current results, conclusion, and future works.

2. Literature Review

Research to find ways to leverage artificial intelligence methods in helping medical systems and personnel began from the early days of the Covid-19 pandemic. Because the detection and diagnosis of Covid-19 at the earliest stages of the disease, at the lowest cost possible was essential to limit the spread of the virus, these research works were deemed to be crucial. Accordingly, computing and medical researchers started using Deep learning methods to analyse radiology images to find accurate methods to diagnose Covid-19.(Ghaderzadeh and Asadi, 2021) There are two main radiology modalities that this research are based on. Around 57% of the research are based on CXR (Chest X-ray) imaging and 40% have been based on CT (Computerized Tomography) imaging.(Ng *et al.*, 2020) Aim of most of these studies has been to only detect and diagnose SARS-CoV-2. Researchers have also been able to differentiate between community acquired pneumonia cases from Covid-19 viral pneumonia using CT images of chest (Li *et al.*, 2020). Due to the limited data availability, transfer learning techniques have been used in most cases.

There are multiple proven model architectures that have been used widely in research work on the detection of Covid-19 in radiology images.(Ghaderzadeh and Asadi, 2021) MobileNetV1 and MobileNetV2 are image classification model architectures based on Convolutional Neural Networks (CNN) introduced by Google. In MobileNetV1 Depth Wise Separable Convolution was introduced and with MobileNetV2 removed non linearities in narrow layers and inverted residual structure of the model. These two models have

shown highly capable in feature extraction and have achieved state of the art performances in object detection and semantic segmentation. Mohamed Abd Elaziz (Elaziz *et al.*, 2020) has used original MobileNet (MobileNetV1) for detection if Covid-19 and in research done in China, Jingwen Li (Li *et al.*, 2021) used MobileNetV2 on CT images to detect Covid-19 cases.

VGG16 is a CNN architecture introduced in 2014 which is considered as one of the best modern vision models. VGG16 is deemed to be unique because it had its focus on having convolution layers of 3x3 filter with a stride 1 and always used same padding and maxpool layer of stride 2 with a 2x2 filter instead of having many hyper-parameters. This arrangement is consistently followed throughout the whole architecture of VGG16. It has 16 layers which have weights, and the architecture is pretty large due to its approximately 138 million parameters. In a research done based in Italy, Luca Brunese (Brunese *et al.*, 2020) used a slightly modified VGG16 architecture CNN model to achieve 97% accuracy on detection of Covid-19 in radiography images.

Resnet50 is also a CNN based architecture based on Residual Networks. Resnet50 has a total of 50 layers with 48 convolutional layers and 1 MaxPool and 1 average pool layers while the original Resnet (Resnet34) had 34 layers. This architecture is also proven to be one of the best in vision models. The use of 3-layer bottleneck blocks improved accuracy and made the training time lesser in the newer Resnet50 architecture. In a research done in China based on community acquired CT images (Li *et al.*, 2020), Resnet50 model was used to detect Covid-19 to achieve high accuracy.

Inception is a family of Network architectures which starts from and consists of newer iterations of the original Inception CNN architecture. It consists of iterations from Inception v1to Inception v4. Each version is an iterative improvement over the previous version which provides improvements in both speed and accuracy.(Mei *et al.*, 2020) Based on the research, for medical applications that includes feature extractions from vision sources, Inception v3 has been widely used due to its suitability.

Other than the CNN architectures mentioned above, Xception, DenseNet and GoogleNet architecture models have also been used in similar kinds of applications.(Wang *et al.*, 2020) In addition to these architectures, Linda Wang (Wang and Wong, 2020) has proposed a tailored CNN architecture for Covid-10 detection. named Covid-Net, which has been able to achieve comparable results to VGG-16 in the detection of Covid-19. After reviewing existing systems and similar medical applications that utilize image classifications, it can be noted that CNN approach would be the most suitable for an application like the proposed

system. This is mainly because of the superiority in accuracy and efficiency of CNNs in classification tasks.

Researc-h	Type	Radiogr-aphy mode	Architecture	Accuracy	Multitask learning Applied
Mohamed Abd Elaziz	Covid-19 detection	CXR	MobileNet	94.09%	✗
Jingwen Li	Covid-19 detection	CXR	MobileNetV2	92.78%	✗
Lin Li	Covid-19 pneumonia detection	CT	Resnet-50	90%	✗
Luca Brunese	Covid-19 detection	CXR	VGG-16	92%	✗
Xueyan Mei	Covid-19 detection	CT	InceptionV2	70%	✗
Shuo Wang	Covid-19 detection	CT	DenseNet121	80.3%	✗
Jenita Manokaran	Pneumonia Differentiation	CXR	DenseNet201	94%	✗

Table 1: Summary of References

3. Methodology

A. Solution

As a solution to the problems mentioned in the introduction, a multitask CNN based system is assumed to simultaneously detect Covid-19 and Covid-19 related pneumonia in a single chest X-ray image of a possible patient for quick, efficient, and cost-effective detection of Covid-19. The multitask CNN model is trained using two datasets, one for the training of the Covid-19 detection task and another for the classification of Covid-19 pneumonia, Normal Pneumonia and No Pneumonia patients. There is only a single type of input to the system. Those are chest X-ray images of a person that is suspected to have contracted with Covid-19. This input image can belong to either of positive or negative classes in the Covid-19 detection case. For the pneumonia detection case, this image can belong to one of Covid-19 pneumonia or Normal Pneumonia or No pneumonia classes. The input images will be used to train the multitask convolutional neural network. There are two classes of outputs from the system. One will be the results for the detection of Covid-19 positive/negative in the given chest X-ray image. Simultaneously, as another output, results for the detection of Covid-19 pneumonia/Normal Pneumonia and No pneumonia will be shown to the users.

B. Datasets

First, datasets consisting of Chest X-rays of the patients were acquired from publicly available online sources.(*COVIDx CXR-2*) The acquired datasets had all the images together and the training labels as a separate text files. This was problematic due to dealing with training labels in a separate file.

Therefore, for the ease of use, text files were first converted into CSV files. These files were then used in a python script to classify the images into separate folders according to their training classes. Figures 2 and 3 gives a summary of the datasets used in this research.
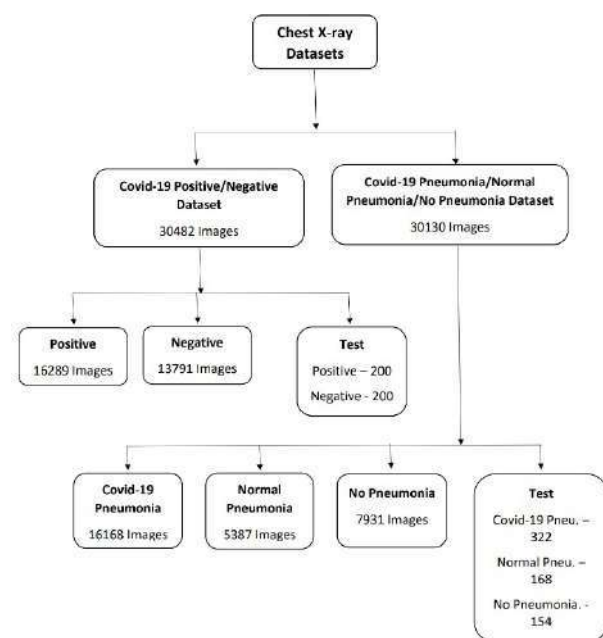

Figure 1: Summary of the datasets

Figure 2: Chest X-rays from the 3 classes of Pneumonia Detection dataset

The input images are pre-processed before being given to the CNN models. Every image is rescaled to 1/255 of the original size, sheared by 0.2 points, zoomed by 0.2 and horizontally flipped. To keep all the images in the same colour, the images are turned to the colour mode grayscale. The same pre-processing procedures are used for both the initial CNN models.

C. Convolutional Neural Network Models

Then custom CNN models were built for each of the two training tasks to identify and test a suitable model to be later transformed into the multitask learning model. Both models need to share the architecture for the most part

and then have the task specific layers at the final stages. The summary of the Custom CNN model used for the positive/negative detection of the Covid-19 is given in the figure 4. The model is built using Keras libraries on top of a TensorFlow backend. The libraries Scikit learn, NumPy and Pandas were also used for the solution on an anaconda virtual environment.

The model consists of Conv2d, MaxPooling2d, flatten and dense layers for the final layers. In this model, output layer has a single node, because the classification is binary. The output layer uses a 'sigmoid' activation function. 'Adam' optimizer and the loss function of 'binary cross entropy is used to compile the model.

Layer (type)	Output Shape	Param #
conv2d (Conv2D)	(None, 498, 498, 32)	320
max_pooling2d (MaxPooling2D)	(None, 249, 249, 32)	0
conv2d_1 (Conv2D)	(None, 247, 247, 32)	9248
max_pooling2d_1 (MaxPooling 2D)	(None, 123, 123, 32)	0
conv2d_2 (Conv2D)	(None, 121, 121, 32)	9248
max_pooling2d_2 (MaxPooling 2D)	(None, 60, 60, 32)	0
conv2d_3 (Conv2D)	(None, 58, 58, 64)	18496
max_pooling2d_3 (MaxPooling 2D)	(None, 29, 29, 64)	0
conv2d_4 (Conv2D)	(None, 27, 27, 64)	36928
max_pooling2d_4 (MaxPooling 2D)	(None, 13, 13, 64)	0
flatten (Flatten)	(None, 10816)	0
dense (Dense)	(None, 128)	1384576
dense_1 (Dense)	(None, 64)	8256
dense_2 (Dense)	(None, 1)	65

Total params: 1,467,137
Trainable params: 1,467,137
Non-trainable params: 0

None

Figure 3: Layers of the Covid-19 positive/negative model

The second CNN model features the same architecture for the most of it but differs in the latter layers. This is to keep a uniform architecture between the two models as much as possible. The output layer of the Covid-19 pneumonia, Normal Pneumonia and No Pneumonia classification model has 3 output nodes in the final layer. This is to accommodate the 3-class prediction. The output layer uses a 'softmax' activation function and a loss function of 'Categorical Crossentropy' is used int this model.

Then after testing the performance of the two models, the Multitask CNN model is to be built. This is designed to use the same layer scheme as the previous CNN models built for testing. It is designed to have two branches in the last layers to accommodate the binary and 3-class

prediction tasks. The model is to be trained simultaneously for the two tasks using the two datasets.

4. Results and Discussion

For the current results, the first custom Covid-19 Positive Negative Detection CNN model was trained using the dataset. It was able to give training accuracies of 97.7% for 20 epochs 97.85% for 25 epochs. After training for 25 epochs, it was able to give a testing accuracy of 94% for unseen data in the test dataset. For both instances, the batch size was set to 32. Figures 4 and 5 given below show the training accuracy, training loss plots for 25 epochs.
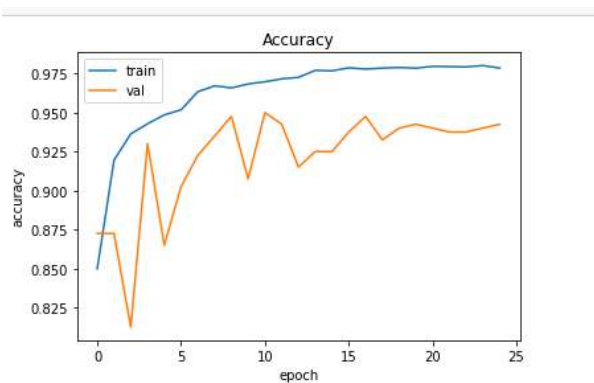
Figure 4: Training Accuracy Plot for the Covid-19 Detection
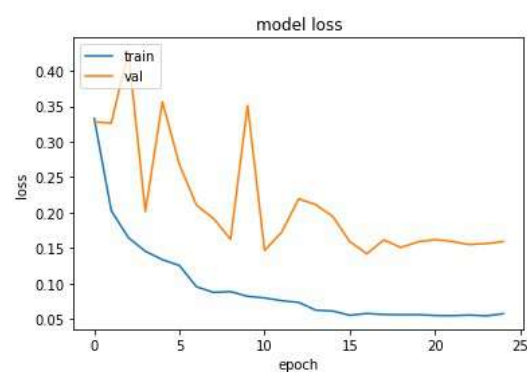
Figure 5: Training loss Plot for the Covid-19 Detection

The following figure 6 and 7 shows the classification report and confusion matrix for the Covid-19 Positive/Negative detection CNN model when trained for 25 epochs and tested with unseen data.

```
               precision    recall  f1-score   support

     Negative       0.92      0.97      0.94       200
     Positive       0.97      0.92      0.94       200

     accuracy                           0.94       400
    macro avg       0.94      0.94      0.94       400
 weighted avg       0.94      0.94      0.94       400
```

Figure 6: Classification Report for the Covid-19 Detection
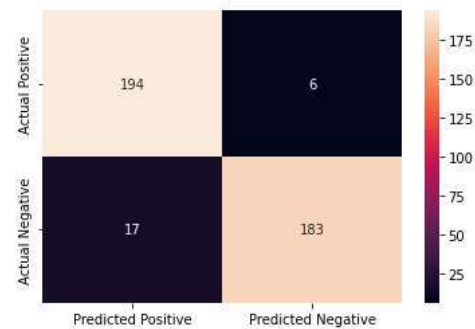
Figure 7: Confusion Matrix for the Covid-19 Detection

Then the same model was modified to accommodate the 3-class prediction of Covid-19 Pneumonia/ Normal Pneumonia and No Pneumonia Detection. The modification which was first made gave an accuracy of 91.9% for 20 epochs and 92.2% for 25 epochs and the batch size was set to 32. But the model did not do well with unseen data, with a low 27% accuracy on testing data. Therefore, further modifications were made on the model and again trained for 32 epochs. At that time the model was able to give a training accuracy of 91.9% and the testing accuracy was 90% on unseen data. The following figures provide Training accuracy, loss, the classification report and the confusion matrix when the model is trained for 32 epochs and tested.
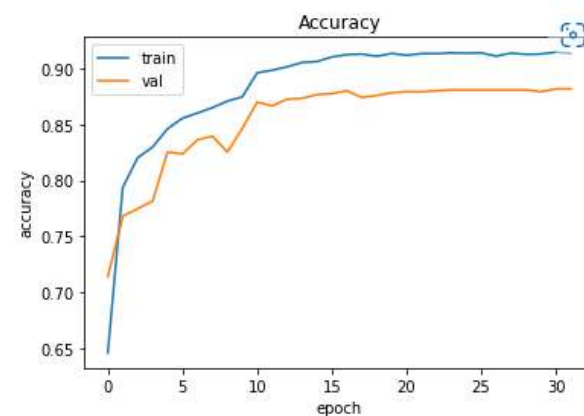
Figure 8: Training Accuracy Plot for the Pneumonia Detection
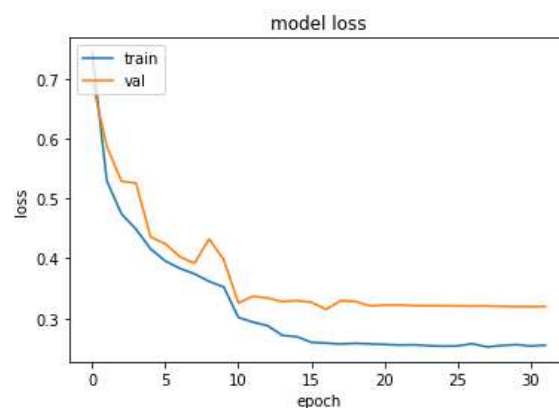
Figure 9: Training loss Plot for the Pneumonia
Detection

	precision	recall	f1-score	support
COVID-19	0.96	0.94	0.95	322
normal	0.85	0.88	0.86	154
pneumonia	0.83	0.83	0.83	168
accuracy			0.90	644
macro avg	0.88	0.88	0.88	644
weighted avg	0.90	0.90	0.90	644

Figure 10: Classification Report for the Pneumonia
Detection
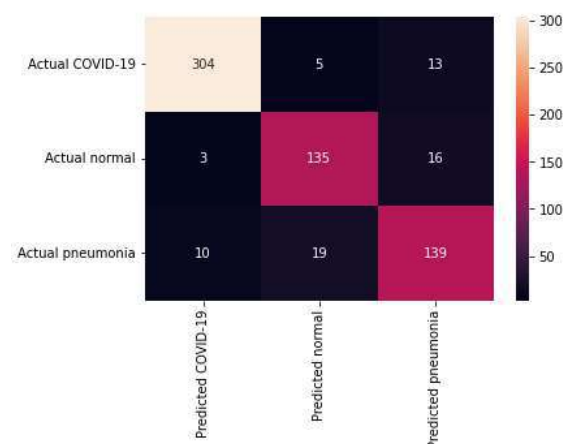
Figure 11: Confusion Matrix for the Pneumonia
Detection

5. Conclusion And Future Works

The testing results for both the training tasks are above
91%. Therefore, the current testing for the two separate
models is within acceptable levels. Therefore, it can be
deemed suitable to use this architecture and design of the
model to be used when building the final multitask
learning model. Although the results that will come out
of the multitask CNN model can slightly vary from the
above results, these results provide the confirmation to
proceed in the direction the research has already tested.

As future works, the final multitask model needs to be
built and tested in the architecture that the current results
confirmed to be suitable. Then it might be needed to
adjust the model to get the highest accuracy possible.
Once the multitask model is built and tested, then the
model is expected to be connected to a web application
to provide users, who can be identified as doctors and
support medical staffs to have intuitive and easy access
to the model to check the results in real-world

applications. With further improvements in dataset size
and quality of the images, the accuracy of the model
could also be increased in the future.

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Future forecasting and analysis of Sri Lankan tea exports in terms of driving forces using data mining concept

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Abstract: *In order to identify new research directions and gaps in the body of knowledge for the time period under consideration, this study concentrated on collecting data specifically related to the Future Forecasting and Analysis of Sri Lankan Tea Exports in Terms of Driving Forces Using Data Mining Concepts. For individuals working in the sector, this research analyzes and projects tea exports depending on the types of tea exported. Finding the elements that lead to fluctuations in tea export volume is made easier by examining the link between tea export and important variables. The prices and volumes of various tea types over that time period, as well as monthly data on tea exports from the previous ten years, were all used in this study. These historical data were utilized to assess and establish the strength of the correlation between the important variables and their patterns of variation in order to forecast tea export volume using WEKA software. Out of a variety of prediction and forecasting techniques, the Multilayer Perceptron, a form of feed forward Artificial Neural Network, was determined to be the most efficient method for creating an accurate prediction model. A confusion matrix was used to gauge the accuracy of the results. With a 98 percent accuracy rate, this forecasting model is suitable for predicting the volume of tea exports. It is also discovered that year, month, and tea types have the highest level of connection among the components in determining Sri Lankan tea export.*

Keywords: *Economic conditions in Sri Lanka, machine learning, and varieties of tea*

1. Introduction

With the planting of a batch of tea seeds at the Royal Botanic Gardens in Peradeniya in 1839, tea was first brought to Sri Lanka. On 19 acres of land on the Loolkandura estate in Hewaheta, James Taylor began the first commercial tea planting in 1867. A complicated input of many cultural practices was needed for the tea crop, which required substantially more effort. Following water in terms of global consumption, tea is the most manufactured beverage. One of the key industries in Sri Lanka's economy that generates significant export revenue is tea. Since it generates the most net foreign exchange on the island today, tea is the most significant agricultural industry. In comparison to Sri Lanka's garment and textile industries, tea exports generate twice as much net foreign cash. As a result, it is believed that the tea industry will continue to be important to Sri Lanka's economy going forward. Employment is one of the ways the tea industry specifically benefits the national economy. Tea's laborintensive production structure results in a high degree of employment. The tea business has supported Sri Lanka's economy for a number of years. The island is definitely veering away from other criteria, like comparative advantages, as evidenced by the present tea industry view. For more than millions of islanders, the tea industry provides their primary source of income. Tea in the forms of bulk, packaged, tea bags, black, green, and white tea are among the varieties exported by the country . For Sri Lanka to maintain a competitive edge in the market, it is necessary to adhere to a number of policies and initiatives. As a result, it is necessary to address the problems in the tea sector and grow the Sri Lankan tea business by utilizing cutting-edge technologies. To increase the competitiveness of Ceylon tea exports globally, it is necessary to further investigate how all the independent features affect tea output and how their positive and negative association through time. By examining the elements that affect tea export, this study's main goal is to increase tea export in Sri Lanka. It gives a brief overview of the important variables that affect Sri Lanka's export of tea as well as their ramifications. This study identifies and analyzes the role that tea export plays in Sri Lanka's economy. On the international market, the major rivals are also identified and their contributions to the tea market are discussed. The study identified the major tea types that are shipped from Sri Lanka to the international market and determined the kinds with the highest and lowest export demand, as well as the proper explanations for each. The goal of this study is to make the research's findings highly accurate. Additionally, this will support Sri

Lanka's Department of Export's efforts to remain competitive on the world stage. The goal of this research is to build a platform that can forecast Sri Lankan tea exports when a specific set of crucial conditions are met.
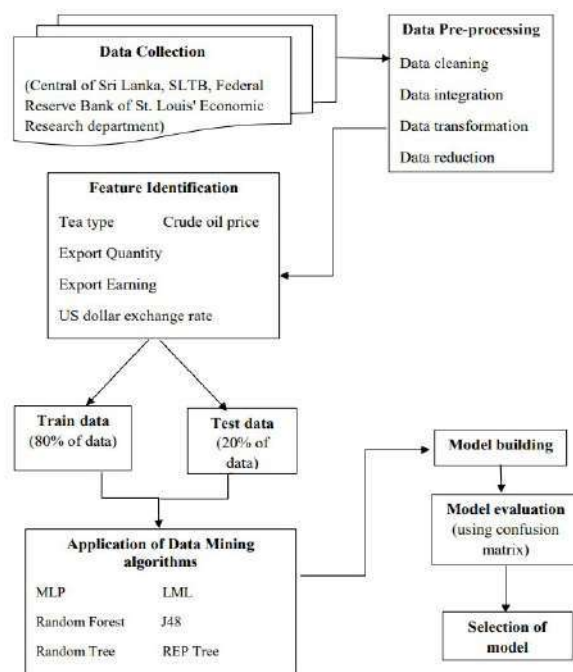
2. Methodology and Experimental Design

Figure 1: Overall Methodology

A. Data collection

Multiple types of data inputs are employed for the compilation of data sets for the previous 10 years, which span from 2011 to 2021. The central bank of Sri Lanka supplied information on several tea sorts including Green tea, Tea in Bulk, Tea in packets, Tea in bags, and Instant tea, while the official website of the Sri Lanka Tea Board statistical section gave data on tea export prices and quantities. The Economic Research division of the Federal Reserve Bank of St. Louis provided the data on crude oil prices, which included daily oil prices from 2011 onward and were converted into monthly prices. Additionally, information about the US dollar exchange rate was gathered from Sri Lanka's central bank. 630 different occurrences were taken into account for the study out of the data collection.

B. Data Pre-processing

Data is dated, imperfect, and noisy in the actual world. Unsatisfactory in that it lacks important feature values and attribute values, or just has aggregate values, noisy in that it contains errors or outliers, and contradictory in that it includes name or code inconsistencies. Why is the data outdated is the next question. Since non-applicable data values might lead to incomplete data when data must be acquired, and the main problem is a variation in thinking between the times when the data was evaluated, together

with human hardware and software concerns. Everyone makes mistakes while entering data, therefore noisy data can happen when a human enters the incorrect value. faulty data collection tools and data transmission issues. There are many different sources of inconsistent data. Duplicate data calls for more data cleansing. With raw data, common issues include noise, missing numbers, and consistency. The caliber of the initial data has an impact on data mining outcomes. Preparing and modifying the initial dataset is one of the most crucial processes in the data mining process since pre-processing data helps to improve data quality, which in turn improves the mining results. The data pre-processing techniques are illustrated in the list below.
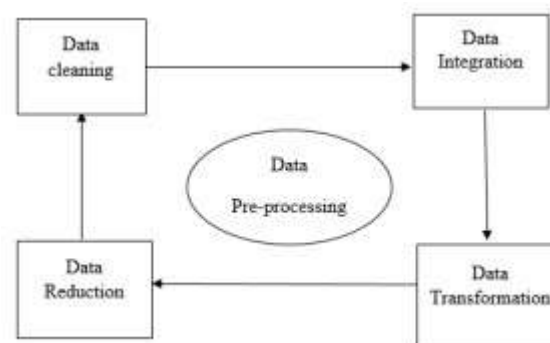

Figure 2: Data Pre-Processing Techniques

During the data cleaning stage, missing values are handled with. It is necessary to perform the duties of identifying outliers, smoothing noisy data, and attempting to repair erroneous data. The determination of some production and export volumes was made utilizing data mining techniques for addressing missing information.

1) Data Integration:

This step involves combining and logically storing data that has been collected from several sources. During the integration process, challenges like identifying similar entities with multiple labels while merging and resolving data value conflicts involving similar entities with various metrics in multiple units are some of the issues that must be resolved. Both during data transformation, there are several periods when merging data and producing aggregate values are employed as ways of data integration. Both of these approaches were used using the dataset on tea exports.

2) Data Transformation:

This step involves combining and logically storing data that has been collected from several sources. During the integration process, challenges like identifying similar entities with multiple labels while merging and resolving data value conflicts involving similar entities with various metrics in multiple units are some of the issues that must be resolved. Before and after data transformation, there are several periods when merging data and producing aggregate values are employed as ways of data integration. Both approaches were used using the dataset on tea exports. The purpose of data mining and various data mining

technologies both call for this, thus it is done. This was done in order to enable for monthly dataset unification and to make sure that the dataset's determining criteria were constant.

3) Data Reduction:

It is used to describe either a reduction in data volume or quality (number of attributes). Due to the fact that the data was manually entered and had few features, there were zero values since further processing might have been done without reducing the data.

C. Feature Identification

The characteristics that have an impact on the research study from the data collected have been determined, including export quantity, export earnings, US dollar exchange rate, and crude oil price.

1) Tea Export:

To establish the pattern of correlation between export volume and sales, which has a significant impact on forecasting the tea export in Sri Lanka in terms of influencing factors, the total amount of exported tea, expressed in kilograms, is studied monthly.

2) Price:

The information provided here pertains to the profits made by Sri Lankan tea exports to foreign nations in LKR. When predicting tea export, this attribute is crucial.

3) Tea Type:

Based on taste, elevation, and structure, tea can be categorized into a number of groups. Some of them include Green, Black, White, Instant, RTD and CTC, High grown tea, Mid grown tea, etc., but only five types—Tea in bags, Tea in packets, Tea in bulk, Instant, and Green tea—were used in this analysis for forecasting that is used to analyze the export in accordance with the types of the tea that are exported from Sri Lanka.

4) USD:

According to this information, the US dollar's value relative to the Sri Lankan rupee has already been shifting significantly over the past few years because of both the country's political policies and its erratic foreign revenue. This had a respectable impact on Sri Lanka's export of tea.

5) Crude Oil Price:

Numerous elements, such as regional shifts in exporting nations, topographical characteristics, and environmental variables, contribute to the swift price fluctuations of crude oil. The European oil market will therefore daily adjust its oil prices as a result. One of the key elements with a significant impact on the nation's tea exports is this characteristic.

D. Model Building for Tea Export Prediction

Typically, classification algorithms are used to extract forecasts from a dataset. Finding a suitable classification method is one of the objectives of this project in order to create a model for predicting tea exports. The class data is analyzed by algorithms along with the different influential elements to produce accurate results. The algorithms then construct a model wherein the parameters are closely related to the class data. The model for predicting tea exports is therefore built and analysed using a variety of classification methods. Classification techniques were trained using the pre-processed tea export data set, which was entered. In order to train the models, information from 80% of the dataset were utilised. A proposed methodology that can estimate the volume of tea exports based on the influencing factors was developed in this study after analyzing how closely the factors matched the class data.

E. Model Evaluation

The leftover 20% of the data set was maintained for testing, and the remaining 80% was utilized for building a model using an appropriate classification technique. The remaining pre-processed dataset was added as a test data set to the model to test it, and the tea export was created for the subsequent steps. The created models were each tested independently by inserting datasets. In order to acquire predictions, the constructed model was loaded after the test data set for the tea export industry was loaded. Utilizing a variety of criteria, including the confusion matrix and its derivations, the performance and efficiency of the algorithms were assessed.

3. Results

A total of 126 occurrences from the full dataset were used to assess the model's precision. The model that provides the highest accuracy was selected for the study after numerous classification algorithms were examined for their Accuracy, Precision, Recall, F-Measure, MCC, ROC Area, and PRC Area. The datasets collected were used to train nine distinct classifiers. The summary findings from using the preprocessed data set as training data for a variety of different classifiers linked to the forecasts are provided in Table 1. The results show that, in terms of affecting factors, the nine distinct classifiers have performed comparably better in predicting Sri Lanka's tea export, with all developed models achieving more than 90% accuracy. Among the numerous classification methods, the Multilayer Perceptron algorithm and Random Forest had the highest accuracy (98%) and the lowest percentages of Mean Absolute Error and Root Relative Mean Squared Error. The proportion of Mean Absolute Error and Root Relative Mean Squared Error of the built model was taken into consideration to determine the best design methodology for tea export prediction of Sri Lanka in terms of influencing factors because the Accuracy, Recall, and F-Measure of the two classifiers are identical.

The study employed an ensemble approach to improve the outcome and developed prediction models using the first five highest accuracy forecasting techniques. The newly built model provided an accuracy of 97.6%, which is less accurate than Multilayer Perceptron and Random Forest classifiers. In order to create the forecasting models for tea export, the study used the Multilayer Perceptron technique.

A. Attribute Ranking

The research hypotheses used for the investigation are ordered according to their impact on the prediction of tea export as shown in the following table, which is based on the analysis of data of the finalized dataset used for the prediction of Tea export in ways that affect factors. Within research study, it was discovered that the elements year, month, type of tea, and export earnings had the most influence on dependent variable export volume, while the factors US dollar exchange rate and crude oil price had the least.

Table 1:Attribute Ranking

Attribute	Rank
Year	1
Month	2
Type	3
Export earning	4
US Dollar exchange rate	5
Crude oil	6

B. Results according to tea types

The study's primary focus is the forecasting of tea export volumes for several tea varieties, including green tea, instant tea, tea in bags, tea in packages, and tea in bulk. According to the data analysis, tea in packages was sent more frequently per month than instant tea, but both were exported on a monthly basis. The second and third largest quantities of tea are exported in bulk and bags, respectively. These results demonstrate that tea in packets plays a significant part in Sri Lanka's export of tea in terms of influencing factors and offers a comprehensive economic rate to the nation.

4. Discussion

The main objective of this research was to examine the elements that affect tea exports in order to increase Sri Lankan tea exports. The study identified the major factors that affect Sri Lanka's tea export and how they affect it. Additionally, the major rivals in the world market are named and their commitments to the tea industry are assessed in terms of export volumes and export prices. The study identified the main tea kinds exported by Sri Lanka to the international market, along with the varieties with the maximum and minimum export demand. While instant tea is at least shipped from Sri Lanka, tea in packets is known to be exported in massive quantities. Nine alternative

classifiers are employed in the search for the optimum performance model for tea export forecasting. The Multilayer Perceptron classifier was identified as the high accuracy model to carry out the investigation by analyzing the accuracy, recall, F-Measure, mean absolute error, and Root mean squared error with the aid of the confusion matrix. The year, month, tea kind, and export revenues all play a vital role in the forecasting of tea exports, according to the final dataset that was utilized for the study.

5. Conclusion

With large foreign exchange revenues, tea has emerged as one of Sri Lanka's most important export crops. The amount and price of tea exported varies from month to month, and it only happens once per month. An extensive range of stakeholders, including 40 tea landowners, brokers, distributors, and consumers, are fervent proponents of tea export. The Sri Lanka Tea Board is the government's national regulatory organization for tea, however at the moment there isn't a mechanism in place to aid in forecasting exports based on different types of tea. Because of this, the aim of this research is to identify a methodology for predicting tea export estimates in the next years. In order to create a suitable prediction model, the features that affect tea export variation were examined in this paper. The Multilayer Perceptron is far more suitable than any classification system for predicting tea export well with the correlation of the affecting parameters. According to the results, the model only produced an error rate of 1.5873 percent. As a result, when compared to the original number, the forecasted export volume is more than 98 percent accurate. Additionally, it would show that the factors have a higher degree of association in affecting Sri Lanka's export of tea. It has been determined that the features Year, Month, and Tea Type have the most impact on Sri Lanka's export of tea, correspondingly.

6. Recommendations for Further Research

This study only extends as far as to create a forecasting model for tea exports. The more the study can produce software based on its conclusions. The model pattern and findings from the research should be the foundation around which the software application is developed. To help the user come to conclusions, the platform must provide elements like previous data entry, the number of forecasting steps required, and graphs that show the data pattern of various components. The establishment of such a structure will be advantageous to the industry as well as those engaged in Sri Lanka. This program can also be useful to people who want to enter the tea industry by developing business opportunities. To create a prediction model, this study primarily determines the types of tea that are exported as well as historical data on tea export. Beyond the scope of this analysis, analyze the specifics of those, auction prices, and tea elevation, and create a predicting model that can predict the volume of tea exported together with auction price in subsequent studies.

Table 2:Comparison of Classifiers - Accuracy And Error Rate

Classifier	Accuracy	Precision	Recall	F-Measure	MCC	ROC Area	PRC Area	Mean absolute error%	Root mean squared error%
Naïve Bayes	92.06	0.932	0.92	0.921	0.853	0.991	0.99	0.0913	0.235
Multilayer Perceptron	98.41	0.985	0.98	0.984	0.969	1.0	1.0	0.023	0.124
Simple Logistic	96.825	0.968	0.96	0.968	0.936	0.999	0.99	0.038	0.123
Decision table	93.65	0.944	0.93	0.937	0.880	0.990	0.99	0.08	0.203
REP Tree	96.03	0.964	0.96	0.960	0.923	0.996	0.99`	0.047	0.150
Random Tree	97.61	0.977	0.97	0.976	0.953	0.978	0.96	0.023	0.154
Random Forest	98.41	0.985	0.98	0.984	0.969	0.998	0.99	0.037	0.126
LMT	96.85	0.968	0.96	0.968	0.936	0.999	0.99	0.038	0.123
J48	97.61	0.977	0.97	0.976	0.953	0.997	0.99	0.03	0.143

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Real-Time Vehicle Type Recognition Using Deep Learning Techniques

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Abstract: Modern intelligent transportation systems heavily rely on vehicle type classification technology. Deep learning-based vehicle type classification technology has sparked growing concern as Image Processing, Pattern recognition, and Deep Learning have all advanced. Convolutional neural work, particularly You Only Look Once (YOLO), has demonstrated significant benefits in image classification and object detection during the past few years. Due to its ability to forecast objects in real-time, this algorithm increases detection speed. High accuracy: The YOLO prediction method yields precise results with few background mistakes. Additionally, YOLO is aware of generalized object representation. This method, which ranks among the best for object detection, performs significantly better than R-CNN techniques. In this paper, YOLOv5 is used to demonstrate vehicle type detection; YOLOv5 m model was chosen since it suits mobile deployments, The model was trained with a dataset of 9200 images, where 2300 images were allocated for each class with a variety of vehicles. Experimental results for 100 epochs with a batch size of 16 show mAP@.5 at 78.1% and mAP@.5:.95 at 71.7% trained and tested on four vehicle classes.

Keywords: You Only Look Once (YOLO), Deep Learning, Convolutional Neural Networks (CNN), Single Shot Detector (SSD) Vehicle Recognition

1. Introduction

Various advancements in the field of machine vision have fundamentally transformed the world. Technology has had an impact on various industries, including transportation. Because of population increase and human requirements, the use of vehicles has risen dramatically. As a result of the increased difficulties in controlling these vehicles, Intelligent Traffic Systems were developed, Vehicle Type Detection systems are critical components of intelligent traffic systems, and they have a wide range of applications [1], including highway toll collection, traffic flow statistics, and urban traffic monitoring. The development of autonomous driving technology has given

people a new knowledge of high-level computer vision, and intelligent transportation and driverless driving technologies have drawn an increasing amount of interest. Vehicle Type Detection is a relatively significant technology in intelligent transportation and autonomous driving. There are already numerous methods for categorizing different types of vehicles thanks to the quick growth of large-scale data, computer hardware, and deep learning technologies. CNN, Faster RCNN, YOLO [2,18], and SSD have mostly used approaches that can be applied. This work uses the most recent real-time object detection technique of YOLO to address the drawbacks of existing object detection systems.

YOLO is a state-of-the-art, real-time object detection system introduced in 2015 by [13]. YOLO proposes using an end-to-end neural network that provides predictions of bounding boxes and class probabilities all at once as opposed to the strategy used by object detection algorithms before it, which repurpose classifiers to do detection. R-CNNs are a type of two-stage detector and one of the early deep learning-based object detectors. The major issue with the R-CNN family of networks is their speed. However, though they frequently produce very accurate results, they were incredibly slow, averaging barely 5 FPS on a GPU. YOLO employs a one-stage detector technique to aid in accelerating deep learning-based object detectors. YOLO has the natural advantage of speed, better Intersection over Union in bounding boxes, and improved prediction accuracy compared to real-time object detectors. YOLO runs at up to 45 FPS, making it a far faster algorithm than its competitors. The GoogleNet architecture inspired YOLO's architecture, YOLO's architecture has a total of 24 convolutional layers with 2 fully connected layers at the end. The main problems with YOLO, the identification of small objects in groups and the localization accuracy— were supposed to be addressed by YOLOv2 [14]. By implementing batch normalization, YOLOv2 raises the network's mean Average Precision. The addition of anchor boxes, as suggested by YOLOv2, was a considerably more significant improvement to the YOLO algorithm. As is well known, YOLO predicts one object for every grid cell. Although this simplifies the constructed model, it causes

problems when a single cell contains several objects because YOLO can only assign one class to the cell.

By enabling the prediction of numerous bounding boxes from a single cell, YOLOv2 eliminates this restriction. The network is instructed to anticipate five bounding boxes for each cell to do this. YOLO9000 [14] was presented as a technique to discover more classes than COCO as an object detection dataset could have made possible, using a similar network design to YOLOv2. Although YOLO9000 has a lower mean Average Precision than YOLOv2, it is still a powerful algorithm because it can identify over 9000 classes. YOLOv3 [15] was proposed to enhance YOLO with modern CNNs that utilize residual networks and skip connections. YOLOv2 employs the DarkNet-19 as the model architecture, but YOLOv3 uses the significantly more intricate DarkNet-53, a 106-layer neural network with residual blocks and up sampling networks, as the model backbone. With the feature maps being extracted at layers 82, 94, and 106 for these predictions, YOLOv3's architectural innovation allows it to forecast at three different sizes.

YOLOv4 [16] is built using CSPDarknet53 as the backbone, SPP (Spatial pyramid pooling), and PAN (Path Aggregation Network) for what is known as "the Neck," and YOLOv3 for "the Head" following recent research findings.

This system uses the latest algorithm, YOLOv5, which uses the PyTorch [20] framework possessing many advantages such as smaller size, higher performance, and better integration than YOLOv4.

2. Related Works

In the works of [2][6], the authors have presented experimental results that that YOLOv4 had better performance, F1score, precision, recall, and mAP values compared to other models in [2] and YOLOv3 has demonstrated better results in performance and accuracy than R-CNN and Fast R-CNN [6]. Yanhong Yang [3] uses the SSD algorithm to achieve vehicle classification and positioning, from the picture collection, picture calibration, model training, and model detection, several aspects of the detailed introduction of the vehicle classification process. PASCAL VOC dataset was used, and TensorFlow framework and SSD model with VGG16 model were used for model training. In [2-9] [11][12] Common vehicle categories are bus, car, truck, bus, and motorbikes. In [6-7] limitations were how to effectively detect vehicles in complex environments. Due to the limitations of hardware and time, in-depth research can be conducted in the future on the aspects of improving accuracy, improving detection accuracy, and improving calibration methods. A combination of YOLOv4 and DeepSORT has been used in [7] for vehicle detection and real-time object tracking, respectively.

In [8] proposes a CNN model for vehicle classification with low-resolution images from a frontal perspective. The

model was trained as a multinomial logistic regression where the cross-entropy of the ground truth labels, and the model's prediction estimates the error. Data augmentation was performed to prevent overfitting. A leaky rectifier activation function (LReLU) instead of (ReLU) was set up for the convolution output. However, [10] proposed a CNN architecture for vehicle type classification. The system requires only one input, a vehicle image. The model consists of two convolution layers, 1st, and 2nd layer. Two pooling layers, four activation functions (ReLU) The 3rd, 4th, and 5th layers are fully connected. In [12] proposed the network developed has a total of 13 layers, 1 convolutional input layer, 11 intermediate layers including a combination of Rectified Linear Unit (ReLU) activation, convolutional, dropout, max pooling, flatten, and densely connected layers, and 1 SoftMax output layer. In the works [6][11] the gathered datasets from public sources such as COCO, OpenImage, PASCAL VOC, and some works their traffic data collected from camera sources. Dataset split was 80:20 80% for training and 20% for testing [6][9].

In the works [17][12] The test data gave it had produced better accuracies with pictures with high definition while for the pictures with low definition, the recognition accuracy decreases. It is also observed that the probability of identifying small cars as medium-sized vehicles is only 8.69%, and the probability of identifying large cars is lower, 2.14% only in [17] and. Further improvements in prediction accuracy include training on more quality images to allow it to extract more features from the data and further dividing into more classes [12]. In [5][10] the authors wish to aim for better accuracies and stability by searching for suitable hyperparameters. Research gaps in [5-7] show the need to cover more variations of vehicles, Cars Image datasets need more data to classify, train, and real-time data analysis of the traffic and also more complex environmental conditions such as night-time and heavy rain. In [8-9][11] images that could be produced were replicated using data augmentation to improve precision and [4] stated image processing techniques were used to improve prediction accuracy. In [11] the authors have used Faster R-CNN, for shareable convolutional layers of RPN and detection network, the improved ZF net is applied on the PASCAL VOC2012 as the backbone network.

In [12] the authors have developed a CNN, to detect types of vehicles commonly found on the road for database collection purposes and improve the existing vehicle recognition for advanced applications. [10] To avoid overfitting Dropout method has been used, and the final layer is the predictor. TensorFlow was used to implement the CNN structures. The hyperparameters for the CNN model were also mentioned which can affect the performance of the CNN. The dataset mentioned was obtained from extracted frames of a video source. In works [11] RPN is trained by using Stochastic Gradient Descent (SGD). The method has better detection average precision for cars and trucks, while the average precision of minivans

and buses is lower. The result might be caused by a little training set of minivans and buses.

Some knowledge gaps were identified in the literature review conducted; many authors have included foreign datasets, resulting in fewer accuracies when tested over real-time data. Some researchers are trying to improve the performance and recognition accuracies by considering images of different lighting, weather conditions, noise reduction, etc. which had been a challenge. According to the works in [2], it is clear that YOLO had outperformed other models such as Faster-RCNN and SSD.

3. Design Framework and Methodology

This section follows the methodology applied to collecting and building the dataset needed for model train/test, exploring, and understanding the architecture behind the YOLOv5, and choosing the best approach for the desired output.

A. Dataset

In this experiment, the gathered dataset was from public sources such as Kaggle, Stanford Cars Dataset, vehicle images scraped from local automotive e-commerce websites in Sri Lanka, and traffic data collected from a video source with the following characteristics: Video duration: 300 seconds, resolution: 1080x2340 pixels, frame rate: 30 FPS. The dataset was prepared for six major types of vehicles, such as cars, buses, vans, trucks, motorbikes, and three wheels. These images are of different illumination, angle, and different vehicle models. The total dataset size is 9,200 images at a resolution of resized to 160x120 pixels, with 2,300 images allocated for each class. The gathered dataset was annotated in YOLO format using a free open source called Labelling to graphically label the images. For each image file in the same directory, a text file with the same name is created in the YOLO labelling format. Each text file provides the object class, object coordinates, height, and width for the accompanying image file. The dataset was split into train and test, which are 80% (7,360 images) and 20% (1,840 images) respectively.

B. YOLOv5

The most cutting-edge object detection algorithm currently in use is the YOLOv5 [19], which Ultralytics introduced in June 2020. It is a novel convolutional neural network (CNN) that accurately detects objects in real-time. This method processes the entire image using a single neural network, then divides it into parts and forecasts bounding boxes and probabilities for each component. The predicted probability is used to weight these bounding boxes. In the sense that it only performs one forward propagation cycle through the neural network, the approach "only looks once" at the image before making predictions. After non-max suppression, it then provides discovered items. YOLOv5 consists of:

- *Backbone: New CSP-Darknet53*
- *Neck: SPPF, New CSP-PAN*
- *Head: YOLOv3 Head*
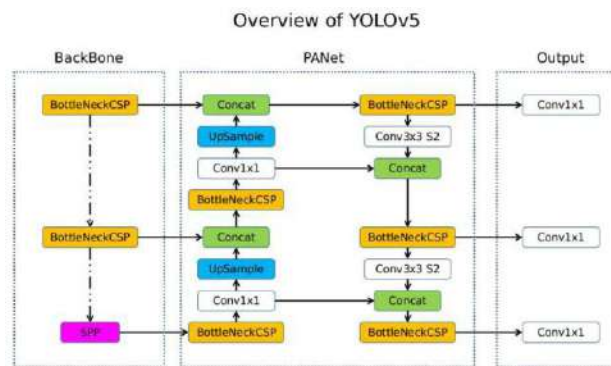
Figure 2. YOLOv5 architecture

The overview of the YOLOv5 architecture is shown in Figure 2. To understand the classes of objects in the data, YOLOv5 models need to be trained using labelled data. The custom dataset that was prepared was of the YOLO format with one text file per image. The text file specifications are:

- One row per object
- Each row is *class x_center y_center width height* format.
- Box coordinates must be in normalized xywh format (from 0 - 1). If your boxes are in pixels, divide *x_center* and *width* by image width, and *y_center* and *height* by image height.
- Class numbers are zero-indexed (start from 0).
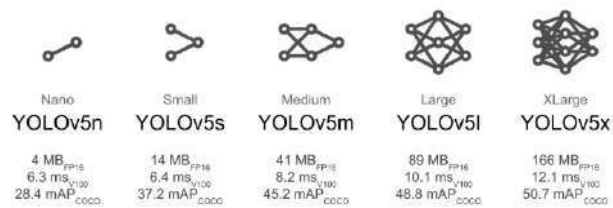
YOLOv5 provides pre-trained models:

Figure 3. YOLOv5 models

Larger models, such as YOLOv5x and YOLOv5x6, will almost always yield better results, but they contain more parameters, need more CUDA memory to train, and run more slowly.

The YOLOv5 loss consists of three parts:

- Classes loss (BCE loss)

- objectless loss (BCE loss)

- Location loss (CIoU loss)

$$L = \lambda_1 L + \lambda_2 L + \lambda_3 L \tag{1}$$

The objectness losses of the three prediction layers (P3, P4, P5) are weighted differently. The balance weights are [4.0, 1.0, 0.4] respectively.

$$L = 4.0 \cdot \quad + 1.0 \cdot L \quad + 0.4 \cdot L_g \tag{2}$$

$$L$$

YOLOv5 uses the following formula to calculate the predicted target information:

$$= (2 \cdot \sigma(\ ) - 0.5) + C \tag{3}$$

$$= (2 \cdot \sigma(\ ) - 0.5) + C \tag{4}$$

$$= \quad \cdot (2 \cdot \sigma(\ ))^2 \tag{5}$$

$$h = \ _h \cdot (2 \cdot \sigma(\ _h))^2 \tag{6}$$

The build targets to match positive samples: Calculate the aspect ratio of GT and Anchor Templates

$$= w_g / w \tag{7}$$

$$_h = h_g / h \tag{8}$$

$$= \max(\ , \frac{1}{\ }) \tag{9}$$

$$_h = \max(\ , \frac{1}{\ _h}) \tag{10}$$

$$= \max(\quad , \ ^h \ ) \tag{11}$$

$$($$

$$= \quad h \tag{12}$$

The final metric, the mAP across test data, is generated by averaging all mAP values for each class in order to z

4. Model Training and Results

The model was trained on a system equipped with Ubuntu 20.04.4 LTS, CUDA 10.2, 32 GB RAM, NVIDIA GeForce RTX 3090, Python 3.8, PyTorch 1.8.0. The yolov5m model was used for the training and test purpose, and a YAML file was defined to configure the paths for the dataset and the number of classes to train (Bus, Car, Motorbike, Van, Truck, Three-wheel).
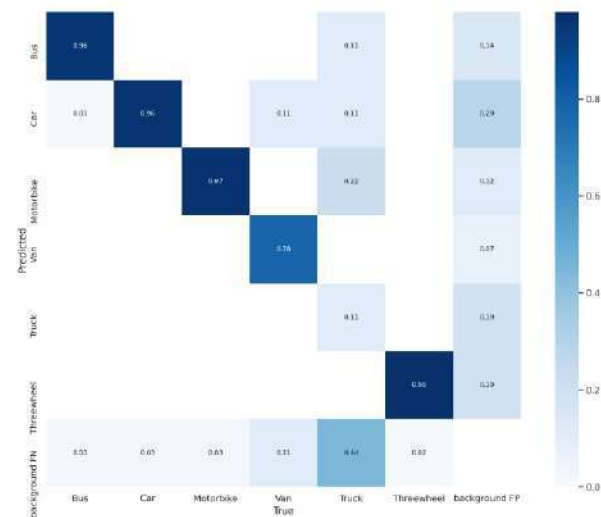
Figure 4. Confusion Matrix

However, it was trained only for 4 classes (Bus, Car, Motorbike, Three-wheel) despite having a few images of trucks and vans included. The model was trained for 100 epochs with a batch size of 16, to visualize and track data in real-time wandb (Weights and Bias) Platform was used.

during training, which allows for determining the epoch where the model starts to overfit. Figure 4 shows the confusion matrix, the only images that were incorrectly classified when the trained model was tested using the validation set were those in which a truck was misinterpreted for a bus and vice versa. This is because, when viewed from the front, a bus, and a truck both have characteristics in common.
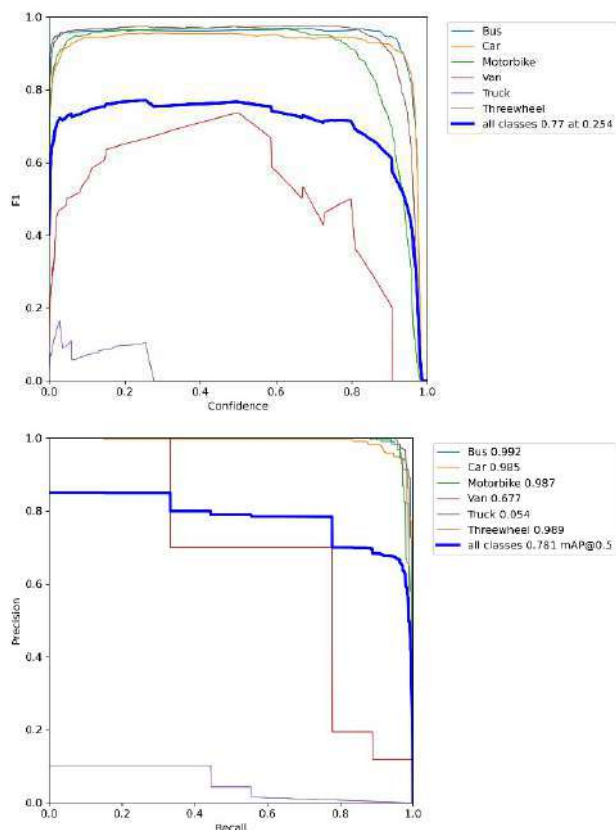
Figure 5. F1 Curve

Class			mAP	
	Precision	**Recall**	**mAP@.5**	**mAP@.5:.95**
Bus	96.8	95.9	99.2	96.9
Car	94.2	96.8	98.5	93.2
Motorbike	96.5	96.4	98.7	90.0
Thre e-	96.7	98.0	98.9	95.0
All	75.4	79.3	78.1	71.7

Table 1. Model results of each class

The mAP@.5 was 78.1% and mAP@.5:.95 was 71.7%. The training results under several epochs 30, 60, and 90 are provided as follows. At 30 epochs mAP@.5 was observed of 71.43%, mAP@.5:.95 of 62.16%, At 60 epochs mAP@.5 of 76.7%, mAP@.5:.95 of 68.62% and at 90 mAP@.5 of 77.96% , mAP@.5:.95 at 71.2%. The best results were found at epoch 93 with a mAP@.5 at 78.066% and mAP@.5:.95 at 71.726%. The following experiment has shown satisfactory results, considering the knowledge gaps identified in the existing research.

5. Conclusion

This paper proposes a model for categorizing vehicle types utilizing the most recent state-of-the-art object detection model, YOLOv5. With an overall mAP@.5 of 78.1 %, the model's promising results. Although the dataset contains 9,200 images with 2,300 each, Bus, Car, Motorbike, and Three-wheel classes were actually trained, Van and Truck classes had very few data since some images had Vans and Trucks captured in the above 4 classes that were trained with, therefore they couldn't be omitted out. However, this result of mean average precision obtained relatively low compared to the higher precisions obtained for classes Bus, Car, Motorbike, and Three wheel due to the classes Van and Truck. However, this can be avoided in the future by annotating those classes which will yield better results. The

The weighted harmonic mean of a classifier's precision (P) and recall (R), considering =1, is known as the F-measure (F1 score). According to the greatest F1 value in Figure 5, the confidence value that maximizes the precision and recall is 0.254. (0.77). Figure 6 presents the precision of each class obtained after the completion of training, it is the proportion of positive identifications which are actually correct, and Figure 7 presents the recall of each class, it is the proportion of actual positives which are identified correctly, the classes Bus, Car, Motorbike and Threewheel displayed satisfactory results although the classes Van and Truck had low results due to lack of images in the training dataset. Figure 8 shows the precision/recall curve generated from the validation set after training completes.

model will, nevertheless, be very successful at recognizing the type of car on the road, as shown by the results. Any future transportation system that must accurately identify the type of vehicle can easily incorporate it. While the classes can be further broken down into a more detailed manner, dividing classes of vehicles as SUVs, sedans, crossovers, jeeps, etc., Following the experiment, it was clear, that the model produced better results with respect to the precision and recall, and it is determined that the model could achieve best results, greater quality photos must be utilized to train the model to allow it to extract more features from the data. Hyperparameter tuning, a better dataset with high-resolution images, increasing the scope of Van and Truck training datasets to enhance precision.

Figure 6. Precision Curve

Figure 7. Recall Curve

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Fuzzy Logic based Learning Style Selection Integrated Smart Learning Management System

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Abstract*: Be cognizant of things that individuals learn, promotes individual learning and motivation. Acquiring the skills and concepts based on understanding things that teachers teach inside the classroom become important. Gender, age, mindfulness, ability, interest, anterior knowledge, learning style, motivation, locus of control, self potency, and phenomenological beliefs differentiates one learner from another. The contribution of this research is to enhance the proficiency of the instructors in preparing the learning materials by considering the learning style of each learner which displayed on students' profile view of the LMS. Referring to previously written research papers, resulted in figuring out that most of the methodologies that are used to detect learning styles are based on advanced pattern recognition techniques which are based on huge datasets. This study results that the use of this inventing feature called fuzzy logic, can reduce the complexity of learning style selection. Rather than using complex algorithms to detect learning styles it works similarly to human reasoning, any user can easily understand the structure of Fuzzy Logic, it does not need a large memory, algorithms can be easily described with fewer data, and easily provides effective solutions to problems that have high complexity and uncertainty while be easily modify the rules in the FLS system. Trials of the learning style selection feature will be tested as the evaluation process. This refers to the process of analyzing the survey results from students. A group of students who knows their learning style via a psychological session will be selected out of a University and each student will be evaluated by a test regarding their learning style as similar to LMS. Results will be compared and find the probability of the truth of the learning style selection feature.*

Keywords*: FLS sytem, MATLAB, Visual and Text Based Learners*

1. Introduction

Learning Management Systems (LMS), Learning Content Management System (LCMS), Learning Design System (LDS) and Learning Support Systems (LSS)are the major four types E-Learning systems. Learning management systems can be use as both virtual learning environment as well as course management system. LMSs provide set of tools and frameworks which allows to create online course contents, attractive teaching, and various interactions with students. Typical LMS provide instructor/ moderator to assess students, monitor students, setting and delivering course contents, and interactive features such as

video conferencing, discussion forums, and threaded discussions[21].

Assessment engines, surveys engines, file repositories, certifications, features to improve gamification, calendars, discussion forums, video conference support, automatic email notifications, skill gaps identification and testing, multi-tenancy, integrate with third-party applications, operability, and multilingual are the most common features that use in modern Learning Management Systems [22].

Digital learning platforms affected students' cognitive abilities and scrutinization levels. Scrutinization level is based on learning materials. Learning materials that contain the entities of each learning style can increase the understanding level of each individual. Felder Silverman proposed a learning style model for engineering learners. Felder Silverman Learning Style Model contains four dimensions. Each of them generates two learning styles that are opposite to each other. Preprocessing dimension produces active and reflective learners. The perception dimension produces sensing and Intuitive learning styles. Input dimension produces visual and verbal learning styles. Understanding dimension produces sequential and global learning styles.

This study is based on major two learning styles that compare above mentioned each learning style. Each learning style can be categorized into either visual which contains images, graphs, audio, videos, and many other attractive objects, or reading which is based on texts, that creates a calm environment that allows each learner to imagine from their minds.

This research aims to implement a Learning Management System that enables learning style selection features using Fuzzy Logic that enables instructors to prepare learning materials based on each individual's learning preference which increases the level of observation in engineering subjects. Instructors interact with the information displayed on the UI and prepare lecture presentations accordingly. This feature will encourage the student's active understanding. In brief research questions of this study are,

1. How can instructors identify the number of learners going under a specific learning style.

2. How to prepare the learning materials using different objects that generate professional outcomes such as performance and satisfaction.

2. Literature Review

A. Evaluate Learning Management Systems

Learning Management Systems (LMS), Learning Content Management System (LCMS), Learning Design System (LDS) and Learning Support Systems (LSS)are the major four types E-Learning systems. Learning management systems can be use as both virtual learning environment as well as course management system. LMSs provide set of tools and frameworks which allows to create online course contents, attractive teaching, and various interactions with students. Typical LMS provide instructor/ moderator to assess students, monitor students, setting and delivering course contents, and interactive features such as video conferencing, discussion forums, and threaded discussions [1].

Thailand is a one of the countries that have the willingness to prepare their youth to meet the demands of a digitally enabled, knowledge worker with critical thinking skills demanded by global industry. Results of the analysis which evaluated the student's satisfaction concerning their use of the PUCSC Model as a learning management tool says, critical thinking ability and learning achievement with the students had a higher critical thinking ability. It also recognized that LMSs are powerful tools in the preparation of critical thinking. Therefore, LMSs such as Moodle becoming widely popular in tertiary education [2].

Study which aimed to investigate whether the adoption of LMS is able to fill their potential through analyzing literatures on LMS usage says, that use of emerging technologies in education can defeat the challenges facing higher education in sub-Saharan Africa. Researchers says success of LMS in the region can measure through assessing the intensity and quality of use in each system. improving usability, enhancing supported services, reviewing policies, increase awareness, make use of mobile applications, and complementing with social media are the strategies that can use to increase the LMS usage. As a result, if the institutions unable to implement the educational technologies they will not reach the success of learning [3].

A survey which conducted through target population of students and instructors of HSE – Nizhny Novgorod campus says, both students and teachers are at ease with computers and using LMS is not perceived as presenting any difficulty for them. Learners perceived that user friendly can imply LMS' s usefulness as a learning tool. Some perceptions coincide in terms of its usefulness as a bank of course materials. Testing, online tasks,

communication activities, and face-to-face learning were preferred as their learning processes [4].

Ref.[5] says that LMS must have positive characteristics such as user-friendliness, flexibility, openness, supports the social and personal needs of students, facilitates feedback, integrated with other systems such as e-portfolios, Web 2.0, email systems, mobile learning services and other systems used at universities, facilitate students' learning, and facilitate students to use the LMS easy to navigate and effective in managing content and user management of effective information, clear instructions and assignments, interactivity, and simple communication tools must include as the important characteristics of LMSs.

B. Several Findings Related to the Learning Management System

Ref. [6] promote a new method to automatically and dynamically select the learning style that proposed by Felder-Silverman based on the number of visits and number of hours spent on learning objects. This research chooses an AI course to evaluate and nine weeks time intervals with 204 learning objects. The method was only based on indications of learner r behaviour whilst learning an online course and as well as it uses simple mapping rule. It doesn't consider the system architecture. Therefore, the proposed method can be used to identify the learning style.

By using various activity spaces and generic tools a LMS was modelled to reach the vision which aims to accelerate the teaching and learning rhythm. Both teachers and learners have personal spaces to create forums. It focusses on making the user, regardless his/ her roles, more active by enabling customize his/her office, creating various activity spaces, aggregate, copy and share resources in activity space. It also can create managing online training systems such as MOOCs. The LMS was focused on user activities. Creating and organizing activity spaces, proposing various types of activities, creating forums, blogs, and managing interaction. It also consists with course, quizzes, forums, instant messenger, and blogs [7].

The research [8] proposing a cross-platform learning management system based on cloud technologies and mobile client applications indicates, simultaneous access to the large number of users, universal enough for the educational services in both higher education and companies, material data, tests, answers were stored in the server, administrator has the ability to add users, teachers can add resources and students can perform many of the educational features as the significant features which are very common in both organizational as well as open source LMSs. The researchers use biometric solutions to secure the user biometric data. to make an innovative IT-ecosystem it will be great to use AI.

The research [9] was conducted in 3 states as analysis, implementation of technical guidance and evaluation of activities. Analysis was conducted via a google form to identify the types of software needed by the participants. Most important step was the technical guidance which

carried out for 4 days with 32 lesson hours. This was conducted by using interactive video conference tools and the activeness in the video conferences became a separate motivation to the resource persons and ended up with a high attendance rate. using technical guidance to avoid the technical barriers that students face during the online learning can improve the participant rate rather than focusing on interactivity. As the research describes the evaluation was carried out by utilizing the online attendance data and survey on the l of preference for the guidance material which reached 98.5% of positive responses.

Hanna fin and Pack approach model used to develop ref. [10] LMS-based E-Learning System. Development model was divided as requirement assessment, design phase, and development and implementation. The LMS that was developed tested among both smaller and larger groups to gather user's response and therefore, researchers were able to measure the level of usability of their LMS. This phase also can help to increase the level of quality. During the development developers used to arrange menu bars and virtual displays. This also equipped the LMS with discussion and video conference menu bar to actively monitor the students during the learning process.

Ref. [11] investigate the issues of LMS evaluation through the User Experience and practice. It also proposing a model which hep to make alternative evaluation of LMS platforms. Lack of mobile features dated appearance and user experience, difficulty of use, poor reporting features, poor customer support and inability to adapt to changing needs are the problems that are currently exist with the LMSs. Poor usability, poor visual design, and lack of responsive design are the design issues that affect customer experience. Contemporary trends of LMS such as Cloud - based LMSs which decrease the cost of ownership, Personal Learning Environment which integrate web 2.0 services which enables several functionalities related to social networks, and the LMSs which engage new approaches such as gamification characteristics or APIs that support incorporation of game mechanics.

course management which focuses on time delivery on a relevant course, social connectivity by replicating social environment via online forums, live chats, and video conferences, Assessments, tracking progress, communication tools, security privacy, ubiquitous access are the old features of the LMSs. In the future the teaching methods become more student focus and it will convert the LMS into an administrative tool. Increased number of uses of mobile devices, improvements of storage and bandwidth promotes the LMSs with new technologies. cloud-like functionalities that discussed before, adaptive learning technologies which enables course designers to design tasks and materials to individual learner requirements, micro learning with LMSs connected devices are the common technologies in these days [12].

The paper ref. [13] proposed to combine both collaborative and uncollaborated biometrics modalities to track a log which is based on face tracking, face verification and collaborative biometric recognition. This research solving the authentication problem in e-learning. If the system unable to identify the user in each period, it will use collaborative verification with fingerprints or voice to confirm whether the user is unauthorized. The system developed using C++ programming language and the image processing library OpenCV. BioAPI-compliant face Biometric Service Provider provides face verification, identification services. BioAPI-compliant voice Biometric Service Provider provides voice-based identification and verification. BioAPI-compliant fingerprint Biometric Access Provider provides fingerprint-based confirmation and identification. Specifically face recognition part is based upon extraction of local Gabor responses at each of the nodes from a 102 rectangular grid over covered on the face recognition.

Cloud technology connects users to services to store, retrieve, manipulate data via the internet. Most of the LMS based on cloud computing and they can provide variety of learning tools to the learners. WizIQ which was establish in 2007, Decebo, Litmos, TalentLMS are some of them. Lower start-Ip cost, Enhanced data security, Improved accessibility, Faster deployment, more storage are the common benefits that can be occur using cloud based LMSs [14]. But for the research area that this paper is going to discuss, using a cloud based LMS may be a cost consuming task. Cloud hosting for single system will be expensive, due to cost of the talent needed, of migration, and of cloud operations.

The system that this research is going to focus on is merging the aspects of both m-learning and e-learning. Therefore, [20] learners will learn on time, access the LMSs via both wireless networks and computer networks, immediate information via mobile learning environment, and sense the learner's environment become significant aspects. students claim difficulties in understanding course materials is a significant observation that claimed by the survey that conducted by this research.

C. Technologies Used in learning style Selection

[16]Research proposed a method to predict learning style based on pattern recognition technique. Architecture of the learning style prediction model describes that sample learners should complete both index of learning style questionnaire and PIJ benchmark. Information that gathered are using to implement supervised training model. Mutual similarity pattern recognition used to identify the learning style of each user.

Three stairs should be taken. Assemble multidimensional space using pretested learning style preference patterns and assemble mutual similarity patterns depend on their learning data which familiar with same learning subject. finally compares the mutual similarity
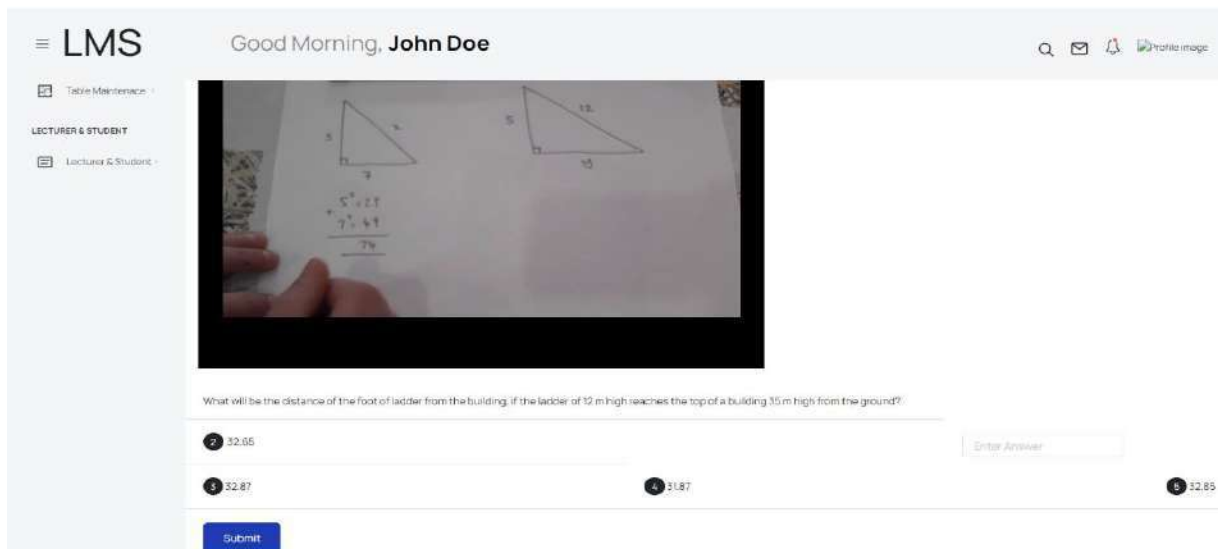
Figure 1. First quiz contains a theorem that elaborate using graphical content. After elaboration, learner should participate on a quiz to obtain marks

pattern with pretested learning style patterns to identify the essential learning style proportions.

learning style preference patterns will have constructed through using normalized learning style data. Active, Sensing, Global, Visual, and Inductive learning styles were considered when Constructing Mutual Similarity Patterns. Aim of identifying essential learning style proportion is to transform multi label classification problem into a single-label classification problem.

This research [17] describes an learning style identification system based on Fuzzy logic. Felder Silverman learning style model used for the learning style classification.

Fuzzy inputs were considered as Felder Silverman Learning Styles Models, Learner's Web Interface Information, Media Wiki E-Learning Server Contents, Student Profile information (domain of interest, educational background, and professional career) for the Fuzzy Inference Engine. Web interface information were gathered as number of mouse movement in the y-axis, ratio of document length to the time spent on a page, ratio of images area to document length and scroll distance, and number of visits to a document. rule base contained 30 fuzzy rules for the purpose of advocating and arranging best e-learning materials based on discovery of learning styles.

[18] Content Based Filtering, Collaborative filtering, and Hybrid Filtering was considered as recommendation techniques. Content based filtering is a primitive method. These recommend system tasks with accounts of learners that they created at the beginning. These personal accounts contain rates for each learning object that is given by therner. This recommendation operation narrows down into three stairs: item representation, profile learning and recommendation generation.

In collaborative filtering algorithm, Target learner preferences considered and compared with ratings included in existing learners' database. Then the learners who have similar preferences found and recommendation made to them for Learning Objects.

Hybrid filtering necessitating two or more recommendation techniques. Previously discussed recommendation techniques used to make person gained recommendations.

Web log files of each learner is considered that contain the etiquette while using the system and contribution in course related tools. To extract learning style Access web logs of each learner, pre-process weblog files, create learning style model, Build tree using decision tree classifier, predict learning style model were taken as major steps[19].

[20]print, aural, interactive, visual, hap tic, kinesthetic and olfactory are the learning styles considered in this research paper. All of these learning styles explains that learners use different media to obtain how the learning material get delivered. Proposed recommend system is based on e learning material ontology. This system contains learning module and a recommender module. Researchers integrate university, corporate, government, payment gateway and bank. These parts used to build new ecosystem in e-learning task. sponsorship, user tracking, payment processors, reporting and applying were used as functional services. The system is based on logic based approach called APARELL.

3. Methodology

This research paper express the Learning style prediction based on two examination results. Each examination is a quiz which include five multiple choice objective response questions. At first time which the student accesses the learning management system will get the chance to attempt

to the two quizzes. First quiz contains a theorem that elaborate using graphical content. After elaboration, learner should participate on a quiz to obtain marks. Second quiz contains a theorem that elaborate using textual content. After elaboration, learner should participate on quiz to obtain marks. Marks of the two quizzes will be evaluated and then the probability of being a visual learner will predict via fuzzy logic system.

Fuzzy logic concept emerged in 20th century and then begin to applied on many other fields. Predicting learning style is the one of the best field that using fuzzy logic.

A. Fuzzy Inputs

Fuzzification of exam results was carried out using input variables and their membership functions of fuzzy sets. Each student contains two quiz results, both of which form input variables of the fuzzy logic system. Each quiz results set (input variables) has five triangle membership functions.

Table 1 . Each quiz results set (input variables) has five triangle membership functions

Linguistic expression	Symbol	Interval
Very Low	VL	0,0,25
Low	L	0,25,50
Average	A	25,50,75
High	H	50,75,100
Very High	VH	75,100,100

B. Fuzzy outputs

The output variable, which is being visual learner value, is entitled "Result" and has five membership functions. For reasons of convenience within the application, a value range between 0 and 1 was chosen.

Table 2. Being visual learner value also contains five intervals

Linguistic expression	Symbol	Interval
Not Visual Learner	N	0,0,0.25
Unsuccessful Visual Learner	U	0,0.25,0.5
Average Visual Learner	A	0.25,0.5,0.75
Successful Visual Learner	S	0.5,0.75,1
Top Visual Learner	T	0.75,1,1

C. Fuzzy Rules

To generate fuzzy output, this research paper considered results of two quizzes. They named as Quiz1 and Quiz2.

1. If Quiz1 is VL and Quiz2 is VL then Result is U
2. If Quiz1 is VL and Quiz2 is L, then Result is U
3. If Quiz1 is VL and Quiz2 is A Then Result is A
4. If Quiz1 is VL and Quiz2 is H, then Result is N
5. If Quiz1 is VL and Quiz2 is VH then Result is N
6. If Quiz1 is L and Quiz2 is VL then Result is U
7. If Quiz1 is L and Quiz2 is L Then Result is A
8. If Quiz1 is L and Quiz2 is A Then Result is A
9. If Quiz1 is L and Quiz2 is H, then Result is N
10. If Quiz1 is L and Quiz2 is VH then Result is N
11. If Quiz1 is A and Quiz2 is VL then Result is S
12. If Quiz1 is A and Quiz2 is L, then Result is S
13. If Quiz1 is A and Quiz2 is A Then Result is A
14. If Quiz1 is A and Quiz2 is H, then Result is U
15. If Quiz1 is A and Quiz2 is VH then Result is N
16. If Quiz1 is H and Quiz2 is VL then Result is T
17. If Quiz1 is H and Quiz2 is L, then Result is S
18. If Quiz1 is H and Quiz2 is A Then Result is S
19. If Quiz1 is H and Quiz2 is H, then Result is A
20. If Quiz1 is H and Quiz2 is VH then Result is U
21. If Quiz1 is VH and Quiz2 is VL then Result is T
22. If Quiz1 is VH and Quiz2 is L, then Result is T
23. If Quiz1 is VH and Quiz2 is A Then Result is S
24. If Quiz1 is VH and Quiz2 is H, then Result is A
25. If Quiz1 is VH and Quiz2 is VH then Result is A
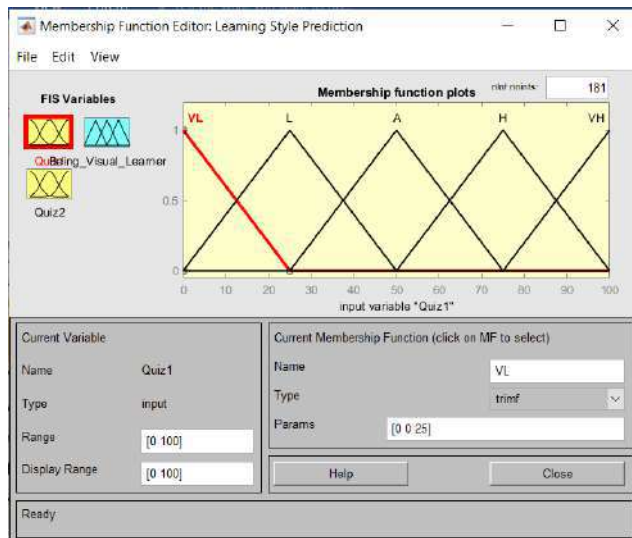
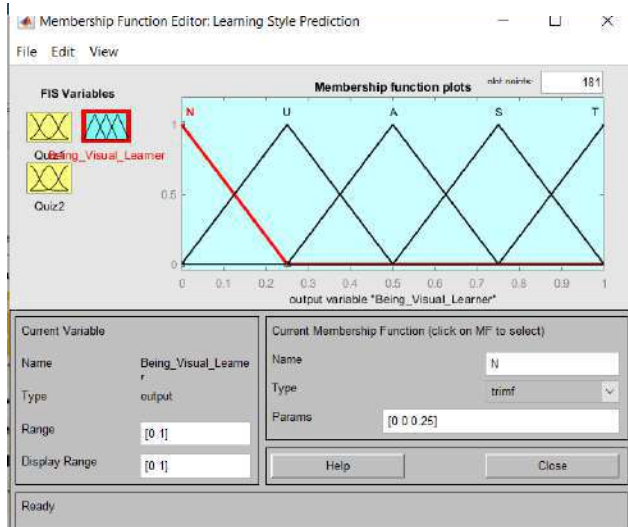Figure 2. Membership function of Quiz1

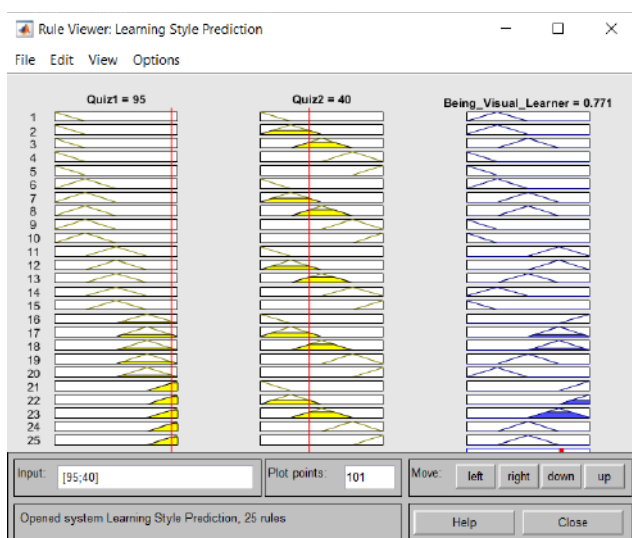Figure 4. Membership function of being visual learner level

Figure 3. Random input and output

4. Discussion

The end product of this research is to boost up the learning style selection by allowing students to participate in two

Table 3. Random inputs and corresponding outputs

No	Quiz1	Quiz 2	Performance value
1	40	65	0.333
2	20	35	0.433
3	50	65	0.355
4	10	20	0.355
5	45	65	0.348
6	34	60	0.374
7	48	55	0.438
8	56	90	0.291
9	74	70	0.546
10	45	50	0.5

separate quizzes the first time that student logs into the system. Lecturers commonly prepare lecture notes by using advanced books and teach them in traditional classrooms. When it moves to remote learning most of the lecturers were unable to return feedback about the enlighten methods that use for the learning material creation and therefore, it makes low-performance levels of the students. Asking students to interact with learning style selection quizzes at first most entry to the system help to categorize students as either visual or reading. As for future work some trials of the learning style selection feature will be tested. This refers to the process of analyzing the survey results from students. A group of students will be selected out of a University and each student can select their learning style. Each student will be evaluated by a test regarding the learning style that they have selected. Learning style selection, make it easier to create, modify and develop more efficient curriculum and educational programs. This also encourages lecturers to motivate their students to gain professional knowledge by using their learning styles. This also influences overall academic performance. This also removes the barriers such as physical, mental, emotional, cultural, or social elements that obstruct a student from achieving their learning goals.

5. Conclusion

Therefore, the understandability of a student depends on their learning style. Sometimes reading a learning material, repeatedly, asking questions, taking good notes, and using visual demonstrators can impact each student from a different perspective. visual, auditory, reading and writing, and kinesthetic are the main four learning styles. This research summarizes each learning style into two major learning styles by considering their attributes and similarities. Visual learners and Reading based learners are the major two categories that may help lecturers when preparing their lecture notes for the students.

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Computerization of Flash Cards in Early Childhood Education

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Abstract: *The education sector of Sri Lanka faced some major conversions with online education due to the Covid-19 pandemic and the country's economic crisis. Early childhood education was undebated in the development stages of the online education concept. This presented study aims at computerizing flashcards for early childhood education by developing an application that helps to fulfill the fundamental foundation of education for Sri Lankan children under the age of eight, with all three native languages Sinhala, Tamil, and English. This system is modelled focusing on detecting an object in an image concerning; the specific categories (numbers, letters, animals, fruits, vegetables) specialized for children under the age of 8 and giving the text as well as the audio output in all three native languages used inside the country. The categories were selected according to the NIE syllabus and their teaching methodologies. The detection process is done through a set of custom-trained models using TensorFlow and Keras. The models are built upon CNN and YOLO algorithms. The ability to get all three native languages are powered through the internal translators that will map the words with the languages. A mobile- based development through Kivy is chosen to ease the detection process, where the user can be given the ability of real-time detection. Each model was trained with 80+ classes that include 100+ images with an accuracy range from 70%-90%, which provides the user with vast diversity and high validity. The focus on developing this system is to introduce an online platform for the learning process of early childhood, which is lacking in the current Sri Lankan education system, and teaching young children all three languages used in means of communication inside the country while prioritizing early childhood education in online learning methodologies.*

Keywords: *Flash Cards, Computerization, Early Childhood Education*

1. Introduction

Developing a lifelong attachment with learning starts from the very early ages of a person. The foundation is necessary for a better future, whereas early childhood education is a crucial ingredient for education. With the globalization and development of technologies, most children are exposed to the technical world. Over the years, many opinions and ideas on computerizing early childhood education were brought into discussions as it has both positive and negative impacts on different aspects. Early childhood education is all about developing the vocabulary with building up understandings of meanings. This is the key for their development of knowledge which is identified as critical on expanding. Therefore, different types of materials and resources are used, which include Flash Cards. Flashcards can be known as the most common tool used in early childhood education. These cards use the Play and Inquiry method, one of the core methods used in education development, making the process more attractive. The concept of Computerizing Flash Cards was brought up from time to time with ideas such as Virtual Flash Cards and Augmented Reality (AR) Flash Cards. These concepts were developed related to the issues on traditional Flash Cards considering psychological, physical, and sensory functions of the children. The computerizing of Flash Cards was focused on contribution and logical grouping to enhance educating children. Traditional Flash Cards included still images that can make the children's perception of the vocabulary limited to a particular perspective. Having only visual clues where pronunciation was absent was another major drawback in Traditional Flash Cards. Screen Timing is the main issue that occurred in the implementation process as too much screen timing can cause attention difficulties, poor concentration, visual difficulties, muscular skeleton injuries, anti-social behaviors, and social isolation, which are significant effects on the physical and psychological wellbeing of children. To become active members of this digital world, children must be equipped and given the experience with proper guidance rather than avoiding computerizing the process of educating children as early experience with digital technologies help them to develop the necessary skills and fluency which is needed for the future. Although integrating technology into child-centered settings is challenging, it is always better to try rather than discuss whether technical tools can affect the education system positively or negatively.

The following research carried out help on the learning and teaching process of children under the age of eight through computerized flashcards. With the given methods it allows to analyze accurate object detection along with the voice outputs. The object recognition algorithms are

designed based on the deep learning models to detect objects using a camera. In addition, voice outputs are given using text-to-speech technologies. This paper introduces a much effective and efficient methodology that can fill a gap in online education sector of Sri Lanka.

2. Literature Review

A. Early Childhood Education

Early childhood is the period from birth to 8 years. This period can be categorized into three major stages according to the age groups as 0-3 years, 3-5 years, and 5-8 years('Technology in Early Childhood Education: Finding the Balance'). Early childhood education is focused on the age group 3-5 years as at that level, children begin to learn by recognizing objects around them through images, symbols, and sounds. This concept is much more complex than presented; at this phase, children tend to expand their vocabulary and understanding (Mertala, 2019; 'EffectivePracticesinEarlyChildhoodEducation.pdf').

In the 1960s, early childhood education was symbolized as one of the significant components in the educating process of children. Most of the children who had the opportunity at that time were from wealthy families. They introduced the concept of homeschooling to educate the children. Early childhood education was mainly focused on the children's cognitive, social, emotional, and physical development('EffectivePracticesinEarlyChildhoodEducation.pdf').To achieve them, different conceptual perspectives of teaching were introduced under four main domains: literacy, numeracy, creativity, and critical thinking('Zomer and Kay - Technology Use in Early Childhood Education A Rev.pdf'; 'Zomer - Technology Use in Early Childhood Education A Rev.pdf').

By the time of 1980's the early childhood education became more outsourced to the society where preschool concepts started to emerge. Still, they were limited to a specific group of children due to poverty and state. By the late 19's, the preschool concept became a trend, and most children got the chance to attend preschools without any difference('EffectivePracticesinEarlyChildhoodEducation.pdf').

The teaching processes were different from country to country due to the economic, social, cultural, and various political environments. Early childhood education expanded its boundaries with the massive parental involvement with globalization(Hägglund and Samuelsson, 2009). By the beginning of the '20s, researchers proved that the IQ level of children with well-designed early childhood education is higher than the others ('Zomer - Technology Use in Early Childhood Education A Rev.pdf').

The current world is a global village where technology has become a part of our lives. Children get exposed to these technologies from an early age. Teaching children the usage of technology from an early age can help them cope with this techno world as they grow. The best way to implement technology to children at an early age is to computerize their educational methodologies.

B. Need of computerized systems for early childhood education

The Digital revolution has profoundly affected how we live our lives with mobile devices and seamless integration of technology in everyday tasks such as shopping, working, reading, finding directions, etc.('Schindler et al. - 2017 - Computer-based technology and student engagement .pdf').Technology is the most fast-growing field, which has made massive changes by digitalizing the daily life of most people('Lindeman et al. - 2021 - Digitalisation in early childhood education a dom.pdf'). The use of computers, mobile devices, and the internet is at its highest level up to date and continues to increase day by day. Technology in computing is a demanding field in many industries with unique opportunities. People struggle to keep up with the everyday changes('Schindler et al. - 2017 - Computer-based technology and student engagement .pdf'), where changes in this path should be experienced, and adaptations should be practiced for existence. This fact proves that learning and equipping them with technology from early childhood will thrive their future self with skills and knowledge on experiences('Fox-Turnbull - Enhancing the learning of technology in early chil.pdf') needed for this fast-growing world.

It is said that "children do not universally wake up on their seventh birthday," in the same way children don't use technology directly. They will have to take experience and get used to the skills needed('Computers and Young Children A Review of Research.pdf'). Computers are already in homes and classrooms, and young children are already using them. And since technology is being used daily, educators can easily take advantage of the power of these tools to enhance the children's learning process('Technology in Early Childhood Education Finding t.pdf').

The World Economic Forum (2019) has stated the pressing issue of the 21st-century skill gap related to the digital revolution and how educators and researchers can address this using technology. Critical components of the 21st-century skill framework include collaboration, communication, critical thinking, and problem-solving, promising outputs on developing essential skills in young children('Kewalramani et al. - 2020 - Technology-integrated pedagogical practices a loo.pdf'). Branstord, Brown, and Cocking stated that "children lack knowledge and experience, but not reasoning ability" in the National Research Council study reports. They also stated that new technologies are consistent with the principles of learning

to solve this issue, such as new interactive technologies making it easier to create environments in which students can learn and technologies helping children visualize the concepts that are difficult to understand. These researchers have also proven that using technology in early learning guides; selecting the tools and creating the environment for changing technologies('Technology in Early Childhood Education Finding t.pdf').

Computerized systems allocated from the very early stages can increase the children's experience while reacting and logically learning the technology. According to Hover and Austin, preschoolers with much interest in technology tend to have higher levels of cognitive maturity as they grow('Computers and Young Children A Review of Research.pdf'). All these facts prove that there is a need to computerize the educational system of early childhood to have a successful life in this globalized village.

C. Approaches on Computerization of early childhood education and its effects on computerizing a traditional methodology

Computerization of early childhood education is complex because there are many classifications and criteria to be considered as this is the basement of education given to the children. Children under the age of eight are playful and active souls that grab knowledge from every minor incident they face. Due to this fact, many researchers and practitioners have given much concern to understanding technology within children's play-based experiences. Implementing technology for this system needs effective planning, instruction, and reviews from test runs('Kewalramani et al. - 2020 - Technology-integrated pedagogical practices a loo.pdf').

An adequate system will consider different views and aspects. Mainly when promoting technology in education, there are two aspects, namely, physical and virtual. Most of the current methods have proven that using a parallel run is the most effective method. This combination can be implemented using theoretical underpinning and frameworks, children's voice STEM-based play and experience, Pedagogy practices, and new realities('Kewalramani et al. - 2020 - Technology-integrated pedagogical practices a loo.pdf'). According to the age group that uses the technology, these methodologies will slightly differ as early childhood education has different weights. There are two main age categories: children between the ages of 3-5 years and children between 5-8 years('Technology in Early Childhood Education Finding t.pdf'). Implementations will be mainly focused on the ways of thinking, ways of working, tools for working, and skills needed for living in this digital world for children. These categories focus on developing the factors, which are social-emotional

development and technology; physical development and technology; cognitive development and technology; language development and technology; mathematics development and technology and literacy development and technology.

To do the developments mentioned above, different types of technical tools are needed. Tools developed under this categories are divided into four main parts: informative, situating, constructive, and communicative tools. All these

facts should be embedded into one source, which can have a positive impact on interactions. Among all the equipment used in early childhood education, such as books, toys, and objects, flashcards are well known as commonly used. The computerization of flashcards is a joint research topic among most researchers on early childhood education('Chen and Chan - 2019 - Using Augmented Reality Flashcards to Learn Vocabu.pdf').

D. Flashcards

We commonly see traditional flashcards as simply as a card consisting of a word, a sentence, or a sample picture (Azabdaftari and Mozaheb, 2012). They bear basic information with images that connects to the meaning of the word presented('Chen and Chan - 2019 - Using Augmented Reality Flashcards to Learn Vocabu.pdf'). Flashcards are commonly used for vocabulary development with a logical method of arrangement targeting words('Werling - The Effects of Technology in Early Childhood.pdf'). They are very famous in the learning and teaching process of early childhood education because of their simple, attractive, and colorful form. Flashcards improve not only language skills but also remembering and memorizing, enriching vocabulary, and analyzing problems. Still, traditional flashcards have only visual clues to the word's meaning; the pronunciation remains absent. They are still cards where only one image is presented per word, limiting the visual perception ('Chen and Chan - 2019 - Using Augmented Reality Flashcards to Learn Vocabu.pdf'). Therefore, a flashcard is the best selection for computerizing early childhood education with the below-discussing implementations and overcoming the above-discussed limitations.

3. Methodology

The proposed system is a portable and easy to use digitalized learning platform for children under the age of eight; which is a mobile application. This is a computerized flashcard system that will read the detected item in all three native languages used in Sri Lanka: English, Sinhala, and Tamil while displaying the word with regard to the relevant language.

The application will allow the user to make a selection on the category of the item to be detected where the categories are specified according to the early childhood education syllabus of Sri Lanka which include numbers, animals, letters, fruits, vegetables, and day to day objects. The below-given diagram shows the overall end product application.
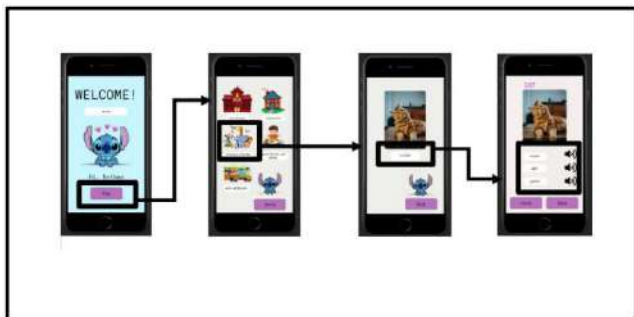

Figure 4 . Overall Application Process

This is the first object detection application introduced to read and display the name of the detected object in all three native languages (English, Sinhala, and Tamil) used in Sri Lanka, specialized for early childhood education. The below given diagram illustrate the simple design process of the application.
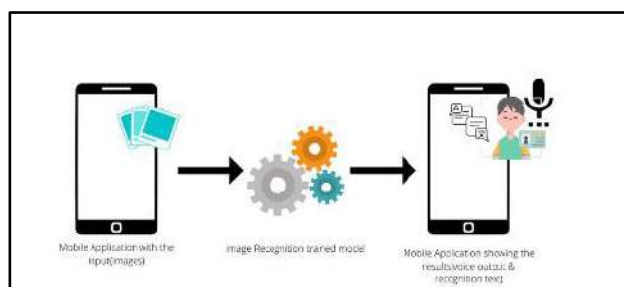
Figure 1. Overall Design Diagram

The application is developed in three different phases; namely the presentation layer, application layer and the machine learning layer. The machine learning layer works on image processing with the datasets fed into the operation. The datasets are then processed and divided into training sets, validating sets and testing sets. While the training and validating datasets are used in developing and training the model the testing data set evaluate the model where the final prediction model was developed. This process was continued with the animal, fruits and vegetable datasets

while the numbers, letters and things around us datasets were simple trained using the YOLO (You Only Look Once) algorithm which is commonly used in CNN (Convolutional Neural Network)developments. CNN models were trained using Keras and Tensorflow libraries using GPU on Jupyter Notebook. Each category is comprised with 80+ classes giving the user a vast range of selections on the detection process. The application layer of the proposed system is built upon a Kivy based front end using python with a text-to-speech and translation collaborations using python libraries googletrans and gTTS(Google Text-to-Speech) . This layer will send the captured image through a pre-processor to the prediction model and recognize the image. This process will take the image through filters, pooling,fully connected layers(FC) and apply Softmax function to classify an object. After that a speech synthesizer will map the word to speech using a text-to-speech(TTS) system. For the development gTTs is used as it gives more native pronunciations where children can get the right interpretation of the voice context related to the region. The application layer or the user level is easy to use; userser-friendly mobile application where the learning and teaching process simple and organized. The below given is the overall physical diagram of the system.
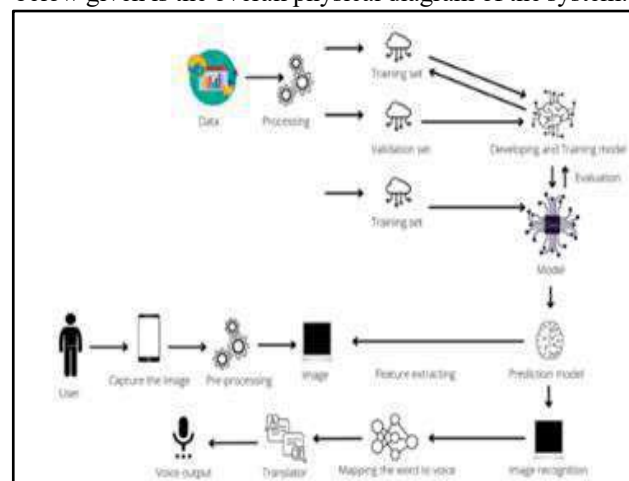

Figure 2. Overall Physical Diagram

4. .Results

This can detect and recognize various categories relevant to the learning and teaching process of early childhood education in day-to-day surroundings such as animals, fruits, vegetables etc. This provides the output on all three native languages in Sri Lanka with audio and textual representations which are highly accurate.Below given table shows the accuracy of the trained models(animals and fruits) which have high accuracy rates.The each individually trained model contained around 20000+ images and 6000+ images with 80+ classes for the testing process where Tensorflow and keras was used in training the model.

Table 1. Results of the trained dataset

Animal Dataset	Trained 22566 images with 80 classes	The model was trained for 16 epochs with 176 per step The final accuracy of the model is 0.6130 with a loss of 0.7652 The validation accuracy of the model is 0.5 with a loss of validation loss of 0.8776
Fruit Dataset	Trained 67692 images with 131 classes	The model was trained for 16 epochs with 528 per step The final accuracy of the model is 0.9947 with a loss of 0.1335 The validation accuracy of the model is 0.9779 with a loss of validation loss of 0.8255
Vegetable Dataset	Trained 15000 images with 15 classes	The model was trained for 5 epochs with 235 per step The final accuracy of the model is 0.9899 with a loss of 0.0318 The validation accuracy of the model is 0.9950 with a loss of validation loss of 0.0172

In this paper the system designed is an object detection system using deep learning object recognition techniques and voice outputs. The system's voice output feature provides a convenience feature for all the users who use different languages. As education sector is one of the areas where deep learning technologies can be applied this development was done for performance testing.

A. Advantages

Computerized flashcards always provide a simple way for students to study and learn with better interactions. With modern technology, kids can learn anytime at anywhere, with the computerization of flashcards. The output in all three native languages give the exposer to the languages used inside the country at a very young age; where the language barriers will be dissolved inside the country.These systems can give instant feedback and reactions than a familiar physical environment where teachers or parents use traditional flashcards. Spaced rehearsal is used in memorizing facts; in conventional teaching methods, the same will have a different effect when repeated by a person, but when computerized, the same thing will be repeated exactly as it was said before. The computerization of flashcards offers movement and multi-dimensional perspectives that will reach students, the visual learners. The main advantage is the kids' massive opportunity by exposing themselves to technology at a very early stage. This process and practice will take them to much better options in their future lives, as the world is moving much faster with technology. The process will teach them ups, downs, and limitations with the experiences most people are lacking.

B. Disadvantages

The most common issue is that even though technology seems to be prevalent globally, not all kids have access to computers, tabs, or mobile devices. Internet facilities are another major drawback that stops the spread of users. Some parents and teachers have both the facilities but lack the knowledge on operating. Most of them are scared to experience the change and only seem to believe in most of society's negativity. Setting up the environments for their kids with limited screen time and overseeing their work is sometimes challenging with the busy lifestyles of the modern parenting styles. One of the significant adversity is that overscreen timing can mix up the real world with a fantasy created by the emotions and feelings of the kids with their age.

5. Conclusion

The weaknesses and limitations in traditional flashcards and the current need of an online platform for children in their early childhood prove that there should be a further developed and an advanced application. The above discussed system will address all the issues with practical and modern methodologies. The below given table shows how the new application will address the limitations in the current flashcard systems with regard to the advanced introduced methodology.

Table 2. Advancements in the proposed system

Application	Limitations	What the new application Provide?
Virtual Flashcards(Azabdaftari and Mozaheb, 2012)	Offer users the necessary information such as words, images, pronunciations, animations, and videos but the scope is not specialized for children	1. The scope is specialized for early childhood education 2. Pronunciation is limited to English
AR Flashcards(Azabdaftari and Mozaheb, 2012)	Mix-up of real-world and fantasy it creates	1.User friendly and easy use, simple application
Orboot app(Tamayo, Gaviria and Rivas, 2016)	An AR application which can mix up the fantasy they create with the real world	1.User friendly and easy use, simple application
Wonderbook(Amalia, 2018)	Offer users to learn spelling of words properly. Limited to spelling learning process	1. Help learning word with visual representations 2. Provide spellings in three languages (Sinhala, English and Tamil)
themesforfun.com(Amalia, 2018)	Free printable English flashcards of how I grow- Day and Night theme flashcards limited to 25 cards	1.Not limited to a certain number of uploads for detection
customizedplayingcards.com(Byrd and Lansing, no date)	language education flashcards teaching the children or students new words. A word on one side and a picture the picture to be recognized on the other side. Lack the proper pronunciation	1.Support kids with proper pronunciation in Sinhala, Tamil and English
printerest.com (Byrd and Lansing, no date)	This application helps to improve the reading skills of children. "Guide" mode represents the flashcards, while the "Type" mode allows checking spellings. Complex operations	
stemcellforautism.com(Byrd and Lansing, no date)	Specialized in representing emotions where positivity, as well as feeling and emotions, are taught. Limited to a one composition	1.Not limited to one area but include specialized areas in developing early childhood education
printrest.com(Good Manners Flashcards)(Amalia, 2018)	These flashcards make the kids name ways to be kind, show love to family, and be a helper. Limited to one composition	1.Not limited to one area but include specialized areas according to the NIE Syllabus

This application can be used widely to provide education to children in their day-to-day life. This is also expected to be used in preschools and daycare centers. In further developments of this system more selection options and exercised-based knowledge-gaining activities are to be implemented. This help in overcoming the threat of not having knowledge on technology with the fast development of the world and the phase drops in education due to the situations we face as a country. As the mobile devices are easy to use and portable this will help to detect objects from the surroundings and give voice outputs. Thus, education is the only path to develop through a life crises. Let us add a bit of technology to make it more effective, efficient, and valuable.

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Facial Recognition Based Temporary Employee Management System

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Abstract*: In Sri Lanka, 90% of temporary workers are employed in the private sector. Overall, around 60% of employees work as temporary workers; out of all 2.8 million private-sector employees in Sri Lanka. Although these temporary workers get a daily wage, they are not promised with continued work in the future; in other words, their job security is much lower compared to other private sector workers. Two of the key issues with their employment are the temporary nature of their occupations and the difficulty in controlling of these occupations because of the lack of permanent set of rules.*

In many workplaces- at present, their work is obtained through brokers. Therefore, these temporary employees as well as the companies face many problems. With the intention of overcoming these issues this paper introduce an automated system for factories, to hire and manage temporary workers without the need of an intermediate broker. This application is developed mainly in four modules; employee registration, employee identification and attendance marking, rating the employees according to their performance, and payroll management. Attendance marking is operated using the (LBPH) face recognition technique. It enables the recognition of the real identities of the employees thus achieving a better level of accuracy in both identity recognition as well as attendance marking. After the identification of the employee, the system will display the tasks assigned to them on the particular day. Tasks are assigned considering the rating value of the employee which will be calculated based on their performance and proficiency on allocated work, as recorded in their work history. The sectional heads are responsible for rating the employees. Their arrival time and date are recorded to ensure the smooth functioning of the payroll system.

Keywords*: temporary employee management system, face recognition, temporary employee*

1. Introduction

As we have stated above, more than half of Sri Lanka's employees work as temporary workers. When comparing the numbers of permanent and temporary employees; the increase of the number of temporary employees within a year, is higher than that of permanent employees. According to the estimations done back in 2013 and 2016, the increase of the temporary employees (in private sector) was estimated to be 350,000 while the increase of permanent employees was estimated to be 15,000. (Jayawardena, 2017).

During the covid pandemic, the recruitment of new employees into many private companies in Sri Lanka had decreased rapidly. It has been revealed that the unemployed population of Sri Lanka had increased by 100,000 in the first quarter of 2020, parallel to the onset of lockdowns (Jayawardena, 2020). Figure 1 shows Sri Lanka Unemployment Rate. (Anon., 2021)
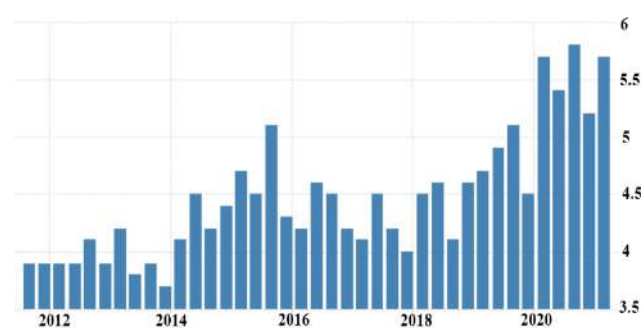

Figure 1 Sri Lanka Unemployment Rate
Source: **(Anon., 2021)**

Many organizations who have temporary employees focus on doing the day-to-day tasks through them. Therefore, unlike permanent employees, temporary employees do not have a fixed monthly salary/ health insurance/ paid vacation/ paid personal days or paid sick days. Also, there is no assurance in these companies, ensuring the continuous service of the temporary employees. But they are a great assets of the company (not each worker individually, but the number of them as a whole), as the company gets maximum service without providing much facilities. Due to the difficulties in handling these temporary employees there is no proper software solution to manage them, other than the manual systems. In some situations there is a broker in between the company and the temporary employee who provides the needed number of workers to the company while managing all the tasks including their payments. Unfortunately, a considerable percentage of the The wages of the temporary employees have to be given to the broker.

As mentioned above, due to the lack of proper software solution to manage temporary employees, they will face many difficulties in finding jobs, getting a salary, and proving their proficiency in work. Also, since all the tasks, including the payment, are handled by an intermediate

broker, these temporarily employees are less rewarded and less paid for their work. There is a timely need of having a hygienic system which is capable enough to use efficiently, even during pandemic situations, as some of the features in existing systems, like fingerprint attendance marking, has chances of further spreading the diseases. This paper introduces a system which can eliminate the above issue as our system will use facial recognition-based attendance marking, which allows the system to manage the temporary employee's attendance more accurately while storing the recorded data.

In 1970, these temporary jobs were introduced in Europe for their companies. Accordingly, many countries had begun to use this method for their companies by 1980.

Figure 2 shows temporary workers (as a percentage) of waged employees, in selected Asian countries. (Huu-Chi NGUYEN, 2016)
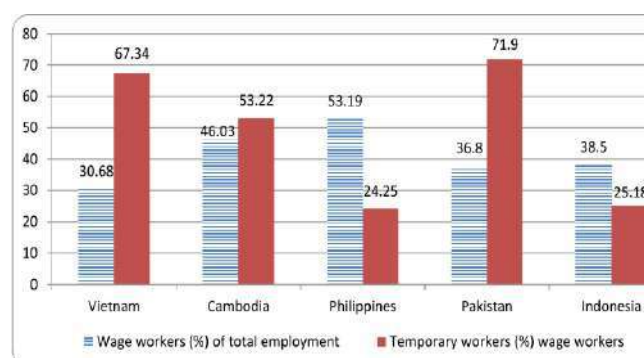
Figure 2 Temporary workers, as a percentage of wage employees, in selected Asian countries.
Source: (Huu-Chi NGUYEN, 2016)

The images above show how temporary workers have spread to other parts of the world in addition to Sri Lanka. Thus, considering the proliferation of temporary workers in Sri Lanka, 56% of the total 4.7 million salaried employees in 2013 were in temporary employment. (Jayawardena, 2017).

Figure 3 shows Temporary workers and permanent employees as percentages of wage employees, in Sri Lanka.
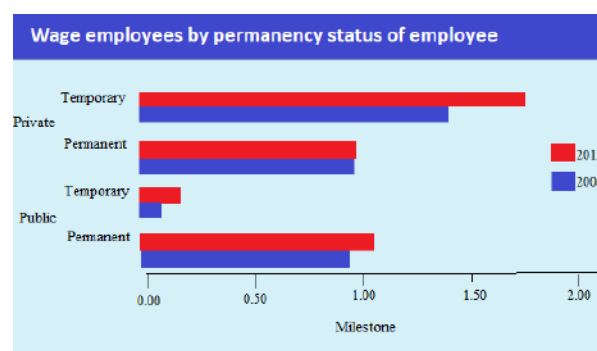
Figure 3 Temporary workers and permanent employees as percentages of wage employees, in Sri Lanka
Source: (Jayawardena, 2017)

In 2016 and 2013, the increase in the number of temporary employees in the private sector was estimated at 350,000 and the increase in permanent employees at 15,000. (Jayawardena, 2017). With the increase in the number of temporary employees, the existing manual system has made it difficult to manage. Hence there is a timely need for developing a software solution for the effective management of the temporarily employees.

2. Literature Review

This research is mainly considered as a solution to find a systematic method to solve the problems of the temporary employees working in the private sector or government, while no systematic solution has been found for all these problems, at present. However, the findings that can facilitate in searching the right solutions are analysed as follows:

An.Employee Identification Methods

Following shows the human identification methods and face identification methods used in various sectors to confirm the identity of people.
Jigar M. Pandya, Devang Rathod, Jigna J. Jadav administered a study on a Survey of Face recognition technique (Pandya JM, 2013). Facial recognition falls under the authentication and validation category.
This research paper describes that the face recognition system is accurate than biometric records consisting of fingerprints, voice, iris, ears, palm geometry, retina, etc.
It also describes the use of Neural networks, geometric function matching, graph matching, Eigen faces and Fisher face recognition strategies.

B.Face Identification Methods

The accuracy of the management of temporary workers with facial recognition is extremely high, as found by above researchers through various scientific studies. Therefore, the method we choose should be able to successfully identify people under different environmental conditions, facial changes, and even with the use of masks.
This section gives an overview on the human resources management and facial recognition techniques for best temporary employee management system. Advantages and disadvantages of each method is also given. The considered methods are eigan faces, local binary pattern, fishar faces, scale invariant feature transformation and speed up robust feature. The approaches are analysed in terms of the facial representations they used.
Manisha M. Kasar, Debnath Bhattacharyya and Tai-hoon Kim achieved a review on a Face reputation the usage of neural network (Manisha M. Kasar, 2016).The research paper highlighted the form of the facial popularity machine. Additionally, defined the neural network and its process. Also, this research paper is focused on approach, algorithms, strategies, database for various systems which is used in face recognition.
Rajat Kumar Chauhan, Vivekanand Pandey, Lokanath M completed a study on smart Attendance gadget using CNN (Rajat Kumar Chauhan, 2018). This gadget defined the

usage of 4 steps initiative is face detection performed supported Histogram of Orientation Gradient (HOG) algorithm. 2d, face alignment is achieved supported face landmark estimation algorithm. 1/3, face encoding, Facenet algorithm-based totally technique is employed for face encoding, it is an accuracy of 99.63% on LFW dataset, finally SVM classifier is skilled with those 128-size values for each face. In technique, there are eight defined steps; enrolment of scholars, educate the gadget, check picture, face detection. alignment, face encoding, recognition, store attendance database.

Jyotshana Kant, Shubha Sharma accomplished in a search on automated attendance; the use of Face popularity supported PCA with synthetic Neural community. Throughout this paper it is described the way for automated attendance system, which makes the use of fundamental factor analysis (PCA) along facet synthetic Neural networks (ANN). The functions of the face snap shots are extracted the use of PCA, which extracts the variations inside the capabilities of face pix, which contains the very first-class statistics with decomposed dimensions (Jyotshana Kant, 2012).

Diverse strategies and methods are proposed to perceive the face. Steady with this Facial detection the use of deep learning research. The most benefits of this algorithm are expertise and approval over different areas. We would like its speed and accuracy to spot, but face detection also has a chain of several related problems. First, it has to digitally look at a photo and discover all the faces in it. Second, specific identification of each face, considering the possibility of a face coming at an unusual angle/ direction or in horrific lighting, while knowing it is nevertheless a separate individual. 0.33 pick out functions, which can be wonted to identify each face uniquely like size of the eyes, face etc. in the end, and examine these capabilities to records we ought to locate the individual's call (Brownlee, 2019)

Adrian Rosebrock written a define about open CV face recognition. It explained the way to use OpenCV to perform face reputation., first perform face detection, extract face embedding from every face using deep learning, train a face recognition version on the embedding, (Rosebrock, 2018)

Qi Jia, Xinkai Gao, He Guo, Zhongxuan Luo, and Yi Wang done a study on a Multi-Layer Sparse illustration for Weighted LBP-Patches based totally countenance recognition. In line with this paper, a singular countenance reputation approach based on sparse illustration is proposed. Maximum present day countenance recognition structures be afflicted by limited potential to handle image nuisances which incorporates low decision and noise. Especially for low intensity expression, maximum of the prevailing training techniques has quite low recognition prices. Prompted by using sparse representation, the matter is often solved by locating sparse coefficients of the check image by using the whole schooling set. Deriving an efficient facial representation from original face snap shots may be an essential step for successful countenance popularity. We examine facial representation supported weighted neighbourhood binary styles, and Fisher separation criterion is employed to calculate the weighs of patches. A multi-layer sparse representation framework is proposed

for multi-intensity countenance recognition, specifically for low-depth expressions and noisy expressions, which may be a vital trouble however seldomly addressed inside the prevailing works. To the present end, numerous experiments based on low-resolution and multi-intensity expressions are administered (Qi Jia, 2015).

C. Employee Performance Calculation

Manasi Ashock, Wasif Ansari, Furqan Ansari and Prof Indu Anoop conducted research for Employee Appraisal Calculation System.it describe Value of an Employees. Who has work at correct time, work hard, has a suitable level of productivity consider as a good performer They also describe evaluating employee's performance is difficult for managers. To overcome this problem, they introduced performance appraisal which will be calculated based on the peer review, HR review and leave record. Also calculated their performance in previous months. In face recognition based temporary employee management system organization wants to quick performance calculation because this system based on temporary employees. Using these areas, we should maintain an automated rating system for temporary employees. (Manasi Ashock, 2020)

Studying literature reveals that the best method is to represent their (employees)values as a rating system. It is extremely easy to identify their performance and automatically build a competition among them. By literature reviews, being fair when evaluating temporary workers' web page is another idea for accurate performance calculation. It shows that, questionnaires and reviews are not suitable for performance calculation because these temporary employees work with different managers as well as different team members. It is way more effectively to evaluate continuously. Some of their given rating system benefits are, it being objective, being reflective to current situation, being adjustable, motivating etc. **(Anon., n.d.)**

Clockify website described Areas we should consider for calculating temporary employee rating system. Also, they described rating system should have same pattern system for all the employees and organization should consider the transparency of rating calculation. They give principal areas for calculating their performance. These areas are Communication, Productivity, Creativity, Integrity, Punctuality and Attendance. **(Fisic, 2022)**

The use of These literature reviews main ideas is focus on automatic rating system, it should be maintaining in section managers, it should continuously evaluate and considering the areas mention in clockfiy website.

D. Employee salary Calculation

According to the Survey on facial recognition based temporary Employee Management system, there are four main methods to get their salary, these methods are by another person, by manpower of the company, directly through the company and other methods. According to these four methods, best method is chosen by conducting a survey; resulted as follows,
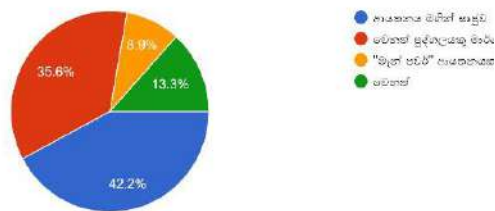
5) ඔබට වැටුප් ලැබෙන ආකාරය
45 responses

Figure 4 Survey Results
Source: Author

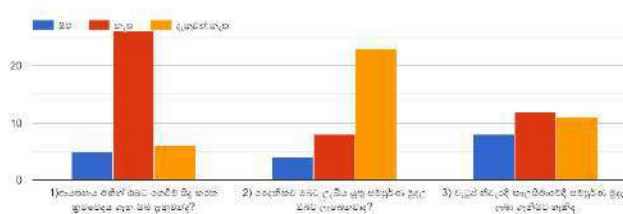6) වෙනත් පුද්ගලයකු මාර්ගයෙන් "මැන් පවර්" සංස්ථාවක් මගින් හෝ වෙනත් ක්‍රමයක් මගින් නම්,

Figure 5 Survey Results
Source: Author

3. Methodology and Design

A. Requirement Gathering and Analysis

This study, which is used to identify correct problem areas of temporary employees who worked in various sectors; we are mainly focused on the that of private sector. For that reason, we conducted a survey using 50 temporary employees. This survey is mainly focused on identifying the limitations of the current systems and the improvements which we expect to include in the proposed system. Other than this survey, we have conducted interviews with the temporary employees.

With the results obtained from this interview and survey, the research objectives were defined and then started to design the proposed system to fulfill each of them. Identified main problems of temporary employees are as follows;

- Attendance marking issues
- Not receiving the full salary given.
- Inability to know the location and direction of their assigned workplace.
- Do not receive recognition for their work
- Problems with labour and time management.

B. Proposed System Design

1) Overall System Architecture: The Overall system architecture is mainly based on three layers. They are Presentation layer, Application Layer, and Database layer. Dataflow of this system is done through these layers. All other subsections of this system are included in these 3 layers.
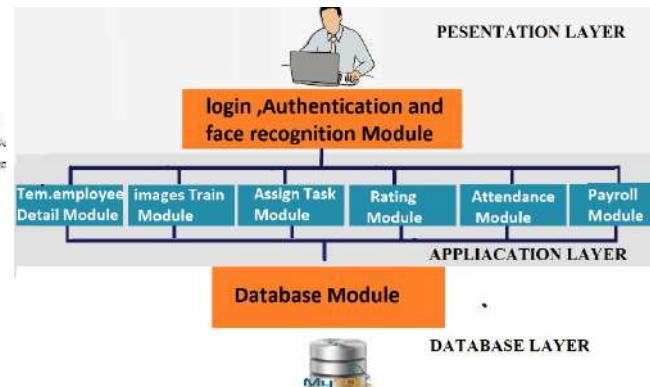
Figure 6 Overall System Architecture
Source: Author

2) System Model Design: The main component is the standalone application, which will perform all the functionalities. Also, there is a this includes web-based system that enable the temporary employees to see their assigned task and their payment details.

C. Technology Adaptation

1) Desktop Application: Facial recognition based temporary employee management system is a desktop application where there are two main roles for the login: Sectional Head and Admin. The functionalities of each role can be described as follows:

- Admin – Registers new temporary employees to the system. Able to edit temporary employee's details, able to see temporary employees' details, captures the temporary employee images and trains those, able to check the attendance sheet, payroll system, and gives salary to temporary employees.
- Sectional Head section – Able to assign the temporary employees to a task, rates the employees according to the performance and the proficiency they have shown in the assigned task.

Figure 7 Desktop Application Home Page
Source: Author

2) Web based Application: Web based system is mainly used for viewing purpose of temporary employees, as desktop application is used for company usage only.
Moreover, its main usages are, new temporary employees can register through the WhatsApp chatbot, get their next day working section details, get their payment details, get location of company using google API in the web system.

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3) Database Architecture: In computerizing temporary worker information, the next question was what specific information should be known about temporary workers?

Thus, temporary employee can register into the system by filling the registration form of company desktop or website. And their collected information such as name, email, contact number, address, their capabilities, what tasks they can do and get their sample images for the face recognition purpose. After registration, company gives full rating marks for them, and assigns works and sections for temporary employees next day requirements. According to their performances they give rating value for the temporary employees. It is recalculated with previous rating marks, and it is done by the sectional heads. These all-rating marks are stored in the database and calculated. Also, payroll management details and next day workers details are managed using the database. Company has both desktop application and web-based system connecting only one database- php MYSQL is used for the database of this face recognition system. System changes can be done by only the authorized people. Web based system mainly use for the view purposes and the registration of temporary employees.

3) Face Recognition Using LBPH Algorithm

In a digital image table of numbers have between range 0 to 255 and the smallest element of digital image is pixel. Dark pixel has small numbers of values and light pixel has high number of values. Local binary pattern is one of technique used for image representation. According to this algorithm image into array. It uses 3*3 pixel.

```
for (x,y,w,h) in features:
    cv2.rectangle(img,(x,y),(x+w,y+h),(0,255,0),3)
    id,predict=clf.predict(gray_image[y:y+h,x:x+w])
    confidence=int((100*(1-predict/255)))
```
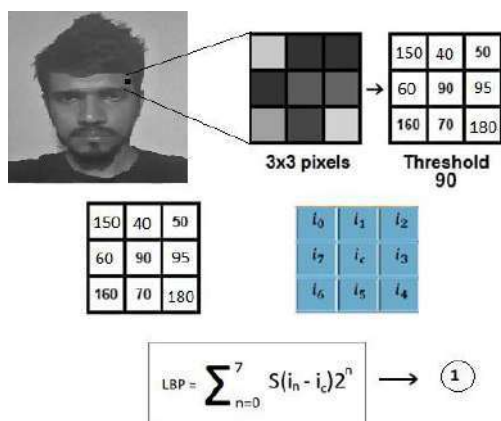

Figure 8 LBPH Calculation
Source: Author

Company gets a set of images of temporary employee and train these images using LBPH algorithm. The LBPH algorithm has an accuracy of 80% is the most suitable model for face identification for temporary employees.

This application was developed as a desktop application for company use and a web system for temporary employees.
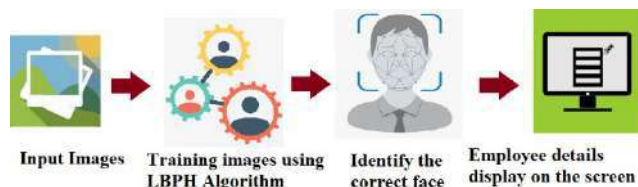

Figure 9 process of face identification
Source: Author

After recognising the employee identity through the face, system displays the assigned working section and task for the particular day. Also, it automatically marks their attendance.

Figure 10 the process after identifying the face
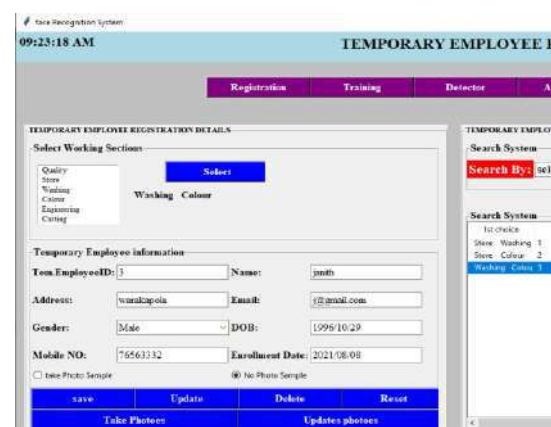Source: Author

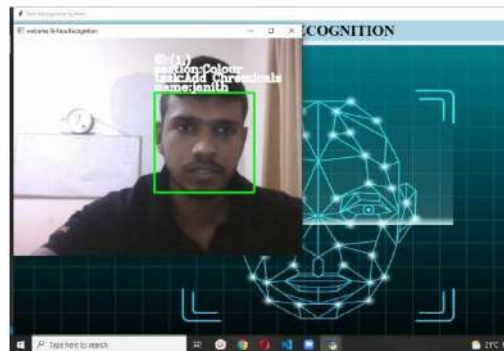Figure 11 Temporary Employee Registration Form
Source: Author

Figure 12 Temporary Employee Identification
Source: Author

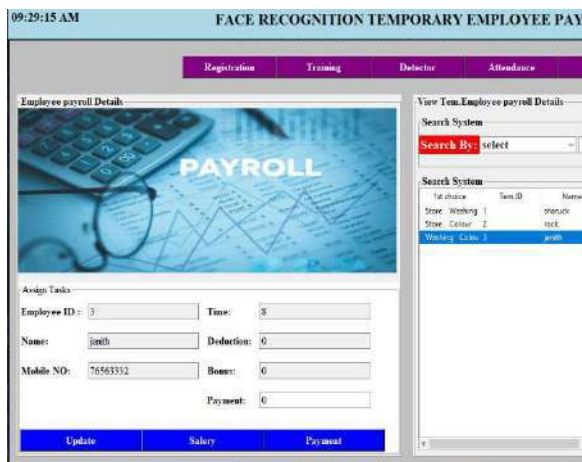Figure 13 Employee Attendance sheet
Source: Author
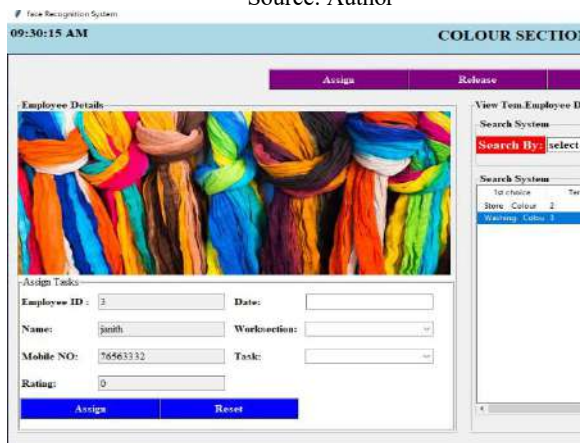

Figure 14 Payroll sheet
Source: Author

Figure15 Section detail sheet
Source: Author

5) Google Map API: It is used for identifying the location of closest *factories.*

*6)WhatsApp Chatbot:*Using WhatsApp chat Temporary Employees can register to the system and give their confirmation for next day's task.

7)Performance Calculation: Rating marks given by sectional heads according to their performance. It is done

by focusing six areas. These areas are communication, productivity, creativity, integrity, punctuality and attendance. Following code shows the rating calculation method of a task. This is the new calculated rating value.

```python
def addition ():
        clear_data()
        add ()
        self.var_n_ratingb.set("")
        firstnumber = int(communicationField.get())
        secondnumber = int(productivityField.get())
        thirdnumber = int(creativityField.get())
        fourthnumber = int(intergrityField.get())
        fifthnumber = int(punctualityField.get())
        sixththnumber = int(attendanceField.get())
        seventhnumber=float(self.var_ratingb.get())
        eightnumber=float(self.var_rating.get())


        answer = (((((firstnumber/4 +
secondnumber/4+thirdnumber/4 + fourthnumber/4 + fifthnumber/4
+ sixththnumber/4)*4)/6)+seventhnumber)/2);

        answerdisplay.insert(10, str(answer))

        total =((seventhnumber+ eightnumber)/2)
        if (total<2.5):
            grade="POOR"
        if (3.5>total>2.5):
            grade="GOOD"
        if (5>total>3.5):
            grade="Very Good"
```

Average method without weighting - Competencies			
Competency	Item numeric rating	Max. numeric rating	Decimal score
Communication	4	5	0.8
Productivity	5	5	1.0
Creativity	3	5	0.6
Integrity	4	5	0.8
Punctuality	5	5	1.0
Attendance	2	5	0.4
Sum of the decimal score			4.6
Section rating calculation			
Total decimal score	Total max. decimal score	Max. numeric rating	Section rating
4.6	6	5	3.8

Figure 16 rating calculation method
Source: **(Fisic, 2020)**

2<Grading Average value < 2.5 = Poor

2.5<Grading Average value < 3.5 = Good

3.5<Grading Average value < 5 = Very Good

4. Results

Here are several test cases that are implemented to validate the proposed system's ability in recognising the identity of person in several types of conditions. Also, after identifying the person, the system should be able to display his/her assigned task on that particular date.

Test Case 1: Validate the face identification of various facial appearances.
Test Data: Persons who are bearded, not bearded and wearing facemasks.

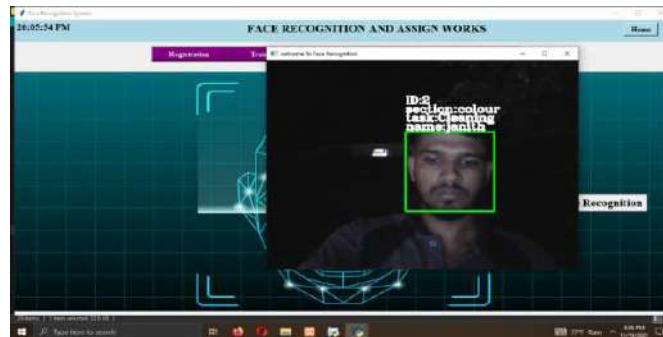Figure 17 Face Recognition with bearded
Source: Author

Figure 18 Face Recognition without bearded
Source: Author

Figure 19 Face Recognition with mask
Source: Author

Test Case 2: Validate the face identification in various lighting conditions.
Test Data: Persons with light background and dark background.

Figure 20 person with light background
Source: Author

Figure 21 Persons with dark background.
Source: Author

Test Case 3: Validate the face identification of various face angles.
Test Data: Persons with different angles.

Figure 22 Persons with different angles test data 1
Source: Author

Figure 23 Persons with different angles test data 2
Source: Author

Test Case 4: Validate the face identification of different people.
Test Data: Different persons.
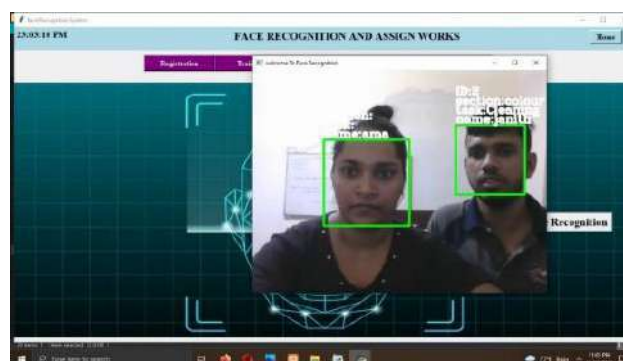
Figure 24 Different persons Test Data 1
Source: Author

Figure 25 Different persons Test Data 2
Source: Author

Test Case 5: Validate the face identification of digital images.
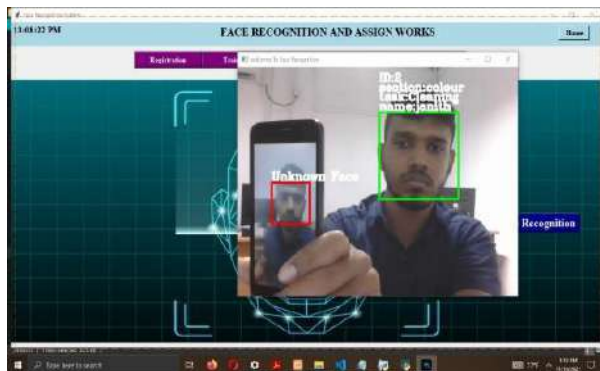Test Data: Digital images taken from a camera.

Figure 26 Test case 5 result
Source: Author

Unit testing have done by using temporary employees of MAS fabric park company. This unit testing has done by considering Login and Authentication Module, Registration Module, Assign Task Module, Face Recognition Module, Rating module and Attendance and Payment module.

5. Discussion

One of the main parts of temporary employee management is the facial recognition system. The reasons to choose Local Binary Pattern Algorithm (LBPH) from other various techniques are its greater accuracy level when identifying the faces and the lower complexity of the algorithm. After capturing data images (nearly 200 images) system is trained with these images using the LBPH algorithm. The system has more than 77% accuracy of performing this task. This system takes about 10 seconds to capture 100 photos and ten seconds to train these photos. As soon as the camera opens, it recognizes the person and displays details such as employee ID, his working section, his task, and his name on the screen.

Employee registration is done by the admin because most of the temporary employees do not have adequate English knowledge to proceed with the system. The agile scrum methodology was followed to develop the proposed system. The development was carried out in four main subsections:

Employee Registration, Attendance Marking, Rating the Employees, and Payroll Systems.

The system can be used only within the company premises. Hence a web system will be developed which facilitates the temporary employees to get the information on their assigned tasks, payment details and location of the assigned tasks. Both desktop system and the web-based systems will work parallelly.

The accuracy of recognizing the faces depends on the environmental conditions and the lighting conditions. However, it can be overcome by capturing more images and having better lighting conditions.

6. Conclusion and Future Works

The main beneficiaries of this software solution are temporary employees and the companies. Through this system, the temporary employees will be able to receive their full stipend without paying part of it to agents and the brokers. Also, the temporary employees can carry out their duties in an effective and convenient way.

In addition, the companies will also be benefited by this system as this facilitate admin to assign employees to predetermined tasks without wasting the time. Also, since the respective sectional heads able to rate the proficiency and performance of the individual temporary employee assigned to that section, at the next instance the admin will be able to select the best employees for each section. With this, companies can get maximum service from the daily workers without wasting time and money.

Since many temporary employees find it difficult to use the system due to lack of English knowledge, we hope to upgrade this system using the Sinhala language in the future.
It is expected to incorporate a chatbot to the web-based system to stay in touch with temporary employees and organizations.
Also, as future work, it is expected to show the details that appear after the phase of face recognition, to make available in any language of their preference.

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A Design Guideline to Overcome Web Accessibility Issues Challenged by Visually Impaired Community in Sri Lanka

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Abstract: *Visual impaired community are the one of the hindrance groups of accessing web content access in the world. The obstacles encountered by this community in their current practices and to develop a best practice guideline to overcome the digital divide in Sri Lanka becomes gap filling of this domain. Preliminary survey indicated that five main problems including 1.) Access limited by the impairment, 2.) Usability issues due to lack of designing, 3.) Unavailability of visually impaired-friendly applications, 4.) Lack of communication, 5.) Web navigation issues are the most dominant pertaining issues. To overcome those issues, solutions are tested and validated with using Design Science approach. Purposive sampling method used and Interviews and questionnaires are used to extracted data. Content analysis also used to derive the result. Results are further validated with using expert opinion. Result Indicate that significant factors need to be incorporate are, ensuring a keyboard-friendly websites, easily accessibility and support with semantic annotation by adding alternative text for images. Furthermore, use headers to structure the content correctly, design all forms to support accessibility in mind including Content developing and designing, navigation, the best colour combination, Pre-recorded video with the audio facilities, braille support in web, the designing option has no significant impact on visually impaired web users. Introducing a rating widget option to a website identifies the level of accessibility features availability facilitates, thereby overcoming the disability digital divide. The results further conclude that a significant difference exists in websites, with and without the involvement of the visually impaired community. Semantic web and semantic annotations of the context of page elements, content serialisation, and navigation by special keyboard commands are also highly influencing the effective use of the web and increase the satisfaction level in the website accessing process.*

Keyword: *Digital Divide, Web content Accessibility, Visual Impairment*

1. Introduction

According to the Ceylon medical journal (Murthy et al., 2018), 285 million people are visually impaired globally from which 39 million are blind. A survey conducted by the Ministry of Health in Sri Lanka (Sri Lankan Ministry of Health Report (2016) found that the occurrence of blindness in Sri Lanka population is 1.7% among the age group above 40. Further, around 9.3 million people in Sri Lanka suffer from some form of vision impairment NPPAB (2020).

One of the biggest issues that the visually impaired population experience is difficulties in accessing Information Technology based services including access to the internet BOIA (2019) and Hollier (2007). To a certain extent, the advances in information technology made it possible to provide access t access to digital devices and web-enabled services such as online banking, e-government services, online shopping, etc. to differently community However, due to various economic and social issues, visually impaired communities in Sri Lanka still confront many difficulties accessing waccessing services. Analysis reveals that there are no detail no detailed studies conducted on how such issues are addressed through policies and guidelines to reduce the disability digital divide faced by the visually impaired community in the country.tive of this paper is to propose a set of guidelines to overcome the disability digital divide among the visually impaired community in Sri Lanka.

2. Literature Review

Visual Impairment (VI) is a significant type of impairment. Various scholars have defined it visually to be inclusive of blindness, while others exclude blindness in their definitions. According to the WHO (2019), The International Classification of Diseases 11 (2018) classifies VI into different groups, remoteness, near presenting, and distance vision impairment: "Blindness" – presenting visual acuity not as good as than 3/60, "Moderate" – presenting visual acuity not as good as than 6/18, "Mild" – presenting visual acuity not as good as than 6/12, "Severe" – presenting visual acuity not as good as than 6/60.

A. Obstacles in Information Inaccessibility

The W3C (2016) briefly introduces five categories of visual impairment that impact in web use. They are Visual acuity (clarity), Light sensitivity, Contrast sensitivity, Field of vision, and Colour vision. In the context of information accessibility, visually impaired individuals are more disadvantaged than the other disabled categories and non-disabled categories. It creates a gap of accessing information which causes the digital divide.

B. Web Accessibility Issues

Raufi (2015)'s study on web accessibility revealed that even though web pages act following Web Content Accessibility Guidelines (WCAG), visually impaired users still face route-finding problems (Navigational) (Power et al., 2012). Ferati et al. (2014) concludes that for blind and visually impaired users, software solutions are not a priori guarantee of digital content accessibility; hence many aspects including the cultural ones need to be considered

(Ferati et al., 2014). Screen reader for the blind is sequentially navigation on the web through nature, although the Internet offers parallel and increasingly non-sequential content.

Web accessibility problems affecting blind users identified by researchers Leporini and Paterno (2008) include:

Lack of page context: Users tend to lose the overall navigational context when visiting and reading minor portions of text within the page. Overcoming this obstacle is possible through the semantic web and semantic annotations of the context of page elements (Fernandes, 2006; Semaan, 2013).

Information surplus due to extreme sequential reading: Static portions of the web documents are often overloaded with links, frames, headers, menus, and footer elements that obstruct the reading process—hence, a large amount of unnecessary data has to be excluded for reaching the desired information. A possible answer that addresses this issue is the concurrent speech method. This method allows blind individuals to find information more speedily (Guerreiro and Gonçalves, 2014; Ahmed et al., 2012). The following design aspects are found obtrusive when considering the visually impaired operators.

Content serialisation: Typically, all content blocks are presented (serialised) in a sequential order without considering the design aspects and relative positioning within hyper-documents.

Navigation by special keyboard commands: Visually impaired users prefer conducting their navigation through specialised keys, which ensure them quick access to required information. Thus, providing keyboard

functionalities is required either through a specific feature in reading software or as a unique tag within hyper-document.

The difference in information conveyance between visual layouts and those afforded by aural perception: Often, for users with no sight issues, when secondary information is given, they can identify it immediately (left or right menu bars, special headers, etc.). Such information must be presented conveniently for visually impaired individuals as well. One such approach, especially for graphs and tables, is seen in MultiVis Project (Kildal and Brewster, 2007) where haptic and non-speech sounds are used for making data visualisations (Silva,2016).

C. Usability and Accessibility Issues of Websites in Sri Lanka

According to Gopinath et al. (2016), web analysis of Sri Lankan Government websites, usability and accessibility standards survey results indicate that websites must ensure that the e-government provides not only better service to the public but also a convenient service to the vision-impaired community of the country. They further stated that it is legally and ethically essential to building e-government sites accessible by visually impaired users. They have already done a survey and identify Most of the Sri Lankan e-government websites do not strictly follow the WCAG 2.0 rules. With using "WAWE" accessibility software 45 government official web sites tested and found 45 are error – free but more than 90 percent of them are faced with inconvenience or inaccessibility for persons with different disabilities. They have already mention that

necessity of WCAG 2.0 success criterion (Level AA and Level AAA).

Furthermore, users who use assistive technologies such as JAWS, NVDA, and Windows Eyes will often find difficulties in navigating the website, obtaining information, completing a task or performing a search request. Without being able to navigate the web page, it is impossible to perform a task no matter how accessible the website is. (Gopinath, 2016).

Therefore, requirement of proper guidelines to follow becomes an important aspect to the country.

According to the Wedasinghe et. al (2014,2015,2017,2018,) studies and literature revels that when this community accesses Web applications, there are five identified categories of problems associated. They are including 1.) Access limited by the impairment, 2.) Usability issues due to lack of design, 3.) Unavailability of visually impaired-friendly applications, 4.) Lack of communication, 5) Web navigation issues.
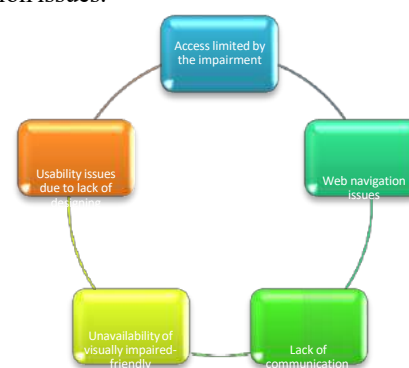

Figure 1: Categories of web accessibility issues

3. Methodology

For each of the above categories proposed solutions was tested in the five different phases. Based on the result recommendations were proposed to develop the guidelines. Policymakers, web designers and developers could use these recommendations in guidelines preparations, and in web and mobile application development processes. The researcher used a design science approach, which is mostly applied for information technology research. In the different phases different research methods were used.

A.Data Collection and Analysis Techniques

In the First Phase consider on the Access limited by the i. In this phase check different checklists to ensure that the identified features are in the existing websites. Select two different types of websites, one with the above facilities, and the other without the facilities.

In the Second phase is consider on the usability issues due to the lack of designing. This activity is the consideration of brail display support and audio device support in the user interface design process to improve usability.

Selecting two different types of websites; One is provided with brail and audio facilities, and the other is without the facilities.

Phase Third is considering the Waiting to Access Visually Impaired Friendly Version to access the website. To check this Website designers and owners can check the website

for compatibility for blind and visually impaired before publishing to the public access to overcome this issue.

In this activity, the experimental method and the following steps were used for validation. A sample website, including visual impaired-friendly options, were added (Text resizing option, Picture description, Voice output option).Users are given an additional option for rating the website by adding a 'rating' option on the site. The feedback of the visually impaired users is evaluated, and conclusions are derived based on the analysis.

Fourth Phase is consider on Lack of Communication issue. This activity includes the visually impaired community in the process of web design and development.

This activity is done by developing one website with the involvement of three blind individuals and another three with low vision individuals. The other website is designed, tested, and developed without the participation of the vision-impaired community. Next, these two websites were given to ten blind and low vision individuals to check the satisfaction level. A questionnaire was given to these participants with answers in a Likert scale (No satisfaction - 0, Little satisfaction - 1, Moderate satisfaction - 2, High satisfaction - 3 and very high satisfaction - 4) To monitor the significant differences in the websites used with the involvement of visually impaired users and without commitment.

In the fifth phase is focuses on web navigation-related issues.ues. This activity was evaluated using five expert opinions in the field of web designing and development— this expertise was selected by using their expertise, especially on web designing and development for the visually impaired requirements. Responses were collected using a Google Form, and data were presented using a pie chart

This research is an outcome-based research approach, where research focuses on the development and performance of the artefacts with the explicit purpose of improving its functional performance.

4. Analysis

The above discussed five Pases research activities analysed and results are present in this section.

Phase 1 - Access Limited by the Impairment

The low vision individuals required screen magnifiers, screen reading software and voice recognition software. Therefore, website designers and developers must consider the assistive software compatibility on websites. Following ten compatibility checks tested to ensure that websites facilitate the following features:

- Make sure the website is Keyboard-friendly.

A visually impaired user has no choice of using a mouse. They cannot locate where to click the mouse. Not as the mouse access keyboard is sequential, access such as blind user needs to tab key unless reaching the target destination. Therefore, keyboard-friendly interactive websites become useful and possibly allow these users to access the Internet. It will assist in overcoming web accessibility issues. Therefore, the following compatibility checks were identified as web page developments:1.) Make sure all content is easily accessible and supported with Symantec

annotation. 2.) Add Alt Text to All Images (Alternative Text for images). 3.) Use headers to structure the content correctly.4.) Design all forms for accessibility.5.) Do not use Tables for anything except tabular data.6.)Enable resizable text that does not break a website.7.)Avoid automatic media and navigation. 8.) Create content with accessibility in mind. 9.) Use the best colour combination for Visually Impaired Community.

Each point given in the above checklist is validated with two different types of websites. One is with a facility highlighted above, and the other one is without a facility. For this validation well known sri Lankan websites such as "http://sinhala.adaderana.lk/" , "http://www.lankadeepa.lk/"," http://www.airforce.lk/", "http://topjobs.lk/", "https://www.csdeafblind.lk/" and spme more popular web sites in Sri Lanka.

A focused group, including ten visual impaired individuals, were selected for validation. A sample is selected with three fully visually impaired, another three with partial visually impaired, and the rest with mild vision difficulties. The participant is surfing the websites and experience the readiness of the websites about the criteria. Next, a five-point Likert scale is used to validate what rating is given for the website with/without the proposed designing features. The Likert scale is divided into following five scales and values starting from 0 to 4 are given; Excellent - 4, Good - 3, Fair - 2, Poor - 1, and Very poor - 0. Finally, values will help to conclude how the proposed design is affected by accessibility. The average of five-point Likert scale values given by totally blind participants with proposed facilities (AVFTB) was calculated using the following formula:

$$AVFTB = \sum_{i=0}^{n} V$$

n= Number of participants, V = five-point Likert scale values given by participants, i=counter

Furthermore, the average of five-point Likert scale values given by totally blind participants without proposed facilities (AVWFTB) was calculated using the following formula:

$$AVWFTB = \sum_{i=0}^{n} V$$

n= Number of participants, V = five-point Likert scale values given by participants, i=counter
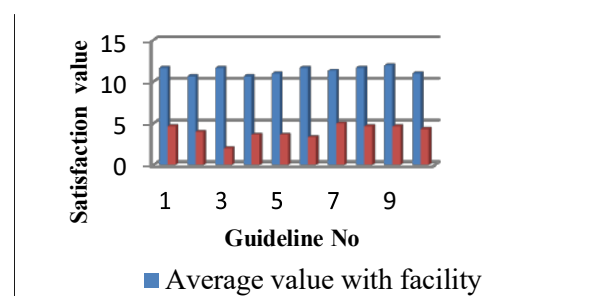

Figure 2: Summary of satisfaction level on different accessibility functions

According to the findings in Figure 2 the bar chart clearly shows that features discussed have significant effects on visually impaired individuals. Therefore, it is recommended for web designers and web developers to increase accessibility among the visually impaired community using these discussed features.

Phase 2 - Usability Issues Due to Lack of Designing This section considers solving usability related issues. Two usability related developments were identified in website developing, as presented:

- Braille display (Braille Terminal) support
- Audio support

The compatibility of braille display is an important factor that website designers and developers must consider. To serve braille readers adequately, theweb developers and designers must evaluate their sites' compatibility with refreshable braille displays. It is recommended to consider WCAG (2.1) guidelines. Therefore, under the WCAG (2.1) recommendations, web designers and developers must consider the following tips (BOIA, 2019):

- The alt HTML attribute used to provide captions for images and another non-textual context. For example, the HTML code <img src="pancakes.jpg" alt="A stack of pancakes"> provides alternative text for a photograph posted in the breakfast in the morning.
- The lang HTML attribute used to specify the natural language of a given web page or passage. For example, the HTML code <html lang="en"> designates that the page is written in English.

Audio support is necessary to consider when the websites contain only a **pre-recorded video.** Web designers and developers must find either an alternative for time-based media or an audio track to provide for visually impaired users.

Three visually impaired individuals were selected, and they were provided with facilities to access a website containing the above features, and others without support. Participants were interviewed to get their feedback on the usability issue. Specific features were monitored, including how the websites that offer brail support and audio support in web usability.

Five experts were interviewed for further validation. According to the findings, it indicated that the brail support is not directly influencing to regular web users, but it directly affects if the content is printing via the web to brail. According to the expert opinion "if the website does not have the brail facility, then it can be converted to the word document and print in the brail without much difficulty.

According to the feedback concludes that audio support is an essential part of web accessibility due to vision difficulty. Participant results showed that 44% of them select a website with audio support, which is convenient for them. Another 37% of them also mentioned that they are satisfied with the audio backing, and the rest of the 26% of the participants mentioned that the website is straightforward to use with audio support.

Participants without the support of audio in the website, and 37 per cent of them showed that "Audio is compulsory; otherwise difficult to understand" and 33 per cent of the participants mentioned that "Difficult me to continue

without audio support." The rest of the 30 participants showed that "Very inconvenient without audio support."

Furthermore, five expert validations also conducted, and all experts emphasized that the voice support for audio is essential to consider. Therefore, web developers need to consider providing a pre-recorded video with audio facilities to overcome the web related issues.

Phase 3 - Waiting to Access Visually Impaired-Friendly Version
As a solution to this issue, propose website designers and owners check websites for compatibility for the blind and visually impaired before publishing to public access. The vision impaired persons who log in to the site recognized from the opening the accessibility level of the website rather than a frustrating reading of the entire website. Therefore, the rating widget and accessibility widget installed on a website are more appropriate for visually impaired persons to show the accessibility level. This method is tested to increase the popularity of the website and motivation for other website owners to increase the website's popularity. It is like most popular travel agents adding their customer rates at the top corner of their websites. Adding this option increased the popularity of the website among the visually impaired individuals.

In this activity, add an accessibility compliance-rating badge to a website, following steps tested using the experimental method.

Design a website, including visually impaired-friendly options added with the following features Keyboard support, Text resizing option, Picture description (Alter Text), Brail output option, Voice output option, Download web content and features a testing tool, Website fully compatible with accessibility features are given with a visually impaired compliance badge can include in an appropriate place on the website. Figure 3 shows the accessibility badge.

Figure 3: Accessibility Badge

Users are given an option to rate the website (according to the accessibility features). Adding a 'rating' option on the website (Adding a rating widget).This rating is always presented on the website.

This activity validated using a focused group with 24 visually impaired individuals. Ten of them were Completely vision loss, and the other fourteen were with low vision. First, they were given the website to access accessibility features and subsequently given five more websites with low accessibility features.

Then they were provided with a Google feedback form to get their response on accessibility.

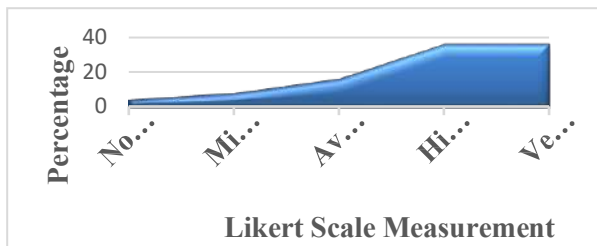Figures 4 and 5 present responses, using area charts.

Figure 4 Response for User feedback on Impact for accessibility badge option
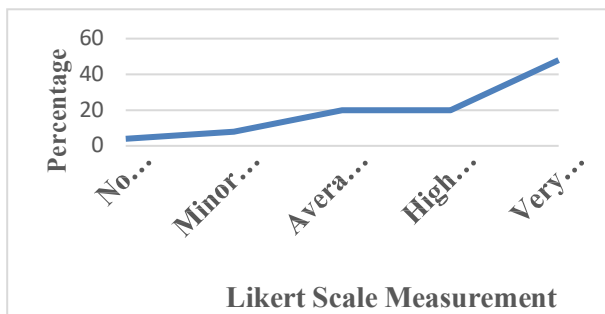

Figure 5: Response for awareness of web developers on accessibility badge option

The response indicated that 36% of them agreed that including an accessibility badge is a very high impact, and another 36% of them have noted its high impact. Only 16% indicated the impact as only moderate. Another 8% suggests that there is little impact and the rest of the four indicated no effect. The majority of visually impaired respondents, which includes 72% of the total respondents, identifies that the impact of having an accessibility badge on a website is high. Therefore, according to the result, it becomes an essential factor to implement. Next, the website owners or designers' view whether it is necessary to consider an accessibility badge was checked at the time of designing and developing a website. Out of all respondents, 48% indicated that it is very high, 20% stated that it is high, 20% reported it is moderate, and 08% indicated little, while the rest of 4% indicate no impact. Since the majority of 68% suggested it as necessary, it is concluded that this accessibility badge is an essential and a considerable web accessibility feature that could be used in the website to overcome the disability digital divide issues faced by the vision-impaired community. This was further validated with eight more expertise in web development and two visually impaired individuals who are experts in the web accessibility area. The response further verified that the result is reliable.

Phase 4 - Lack of Communication
This activity is to consider the effectiveness of including the visually impaired community in the process of web designing and development to overcome the web accessibility issues. Web designing and development are starting from the requirements of the gathering stage, designing and development of the website, followed by implementation of the website. In every step in this process, it is necessary to actively involve the visually impaired individuals to get the real requirements and testing of the website accessibility requirements. They have practical experiences of accessibility issues.

This activity is validated by developing one website with complete vision n loss 03 individuals and others with low vision impairment. Another website was tested designing and developed without the participation of the visually impaired community.

The two developed websites were given to ten fully visually impaired and partially visually impaired individuals to detect the user-friendliness of the website and their satisfaction levels. These participants were given a questionnaire with answers in a Likert scale (No satisfaction - 0, Slight satisfaction - 1, Moderate satisfaction - 2, High satisfaction – 3, and very high satisfaction - 4), to monitor the significant difference in the websites developed with and without involving visually impaired   users.
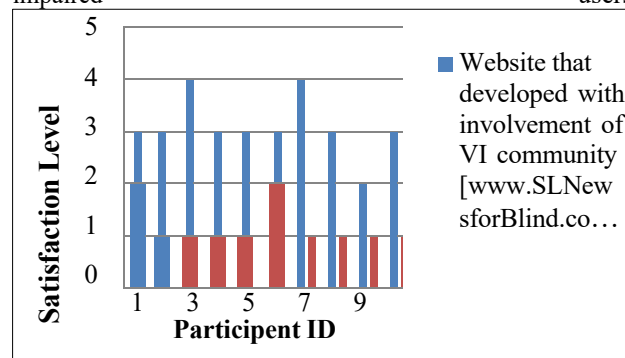

Figure 6: Evaluating VI involvement and without the involvement of website designing

According to the responses, 90% of the participants were with high and very high satisfaction levels for the website that developed with the involvement of visually impaired participants. The other news website received light and moderate satisfaction levels. Therefore, it encourages website designers and owners to include visually impaired individuals in the website development process. For testing the website using web accessibility compliance tools, four experts tested and validated the website to improve the reliability of the result.

Phase 5 - Web Navigation Issues
Navigation on the web through a screen reader for the blind is sequential by nature, although the web offers parallel and increasingly non-sequential content. There are two main problems addressed in this activity. The first one is the lack of page context. In this, visually impaired users are navigational context when they are visiting another web page to read the small information portion of the text. Therefore, the overall focus of the content is challenging to keep. Comparatively, with non-visually impaired web users, visually impaired users get more frustrated in designing these web pages. This can overcome through semantic web and semantic annotations of the context of page elements.
The next problem address is Information overload due to excessive sequential reading. Static portions of the web documents often overloaded with links, frames, headers, menus, and footer elements that obstruct the reading process. Unnecessary data must omit to identify the desired information to reduce of getting frustrated in this web accessing process.

A possible solution that addresses this issue is, either using concurrent speech methods that allow blind users to find information more quickly or through skimming (i.e., grasping the tip of the information to determine its content quickly).

In addition to the above solution, content serialization is also one alternative. In this method, typically, all content blocks presented (serialized) in a sequential order without considering the design aspects and relative positioning within hyper-documents.

Another solution proposed is navigation by special keyboard commands. Visually impaired users prefer conducting their navigation through specialized keys. Therefore, ensuring keyboard functionalities is required either through a specific feature in reading software or as a unique tag within hyper-document.

Two websites evaluated in this activity were compared. One website was developed with Symantec web option, content serialization, and navigation through particular function key option. Another website was selected that does not contain the above three features. Then selected a focused group with twenty visually impaired samples, including fully visually impaired and low vision people. After using the websites, a Google form questionnaire was given for them to fill.

The analysis of the responses is shown below, and the following URL inactivate online.

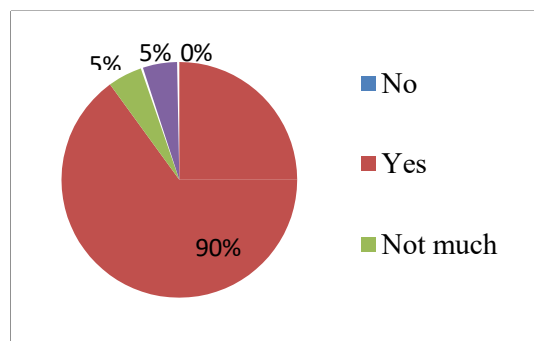Responses are presented in Figures 7 to Figure 9, using pie charts.

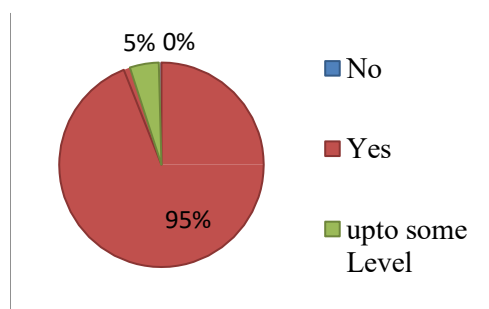Figure 7: Responses for navigation issues in website 1

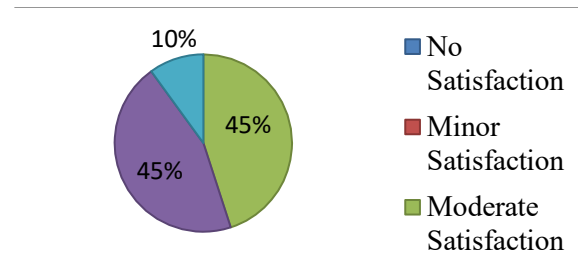Figure 8: Responses for navigation issues in website 2

Figure 9 Responses for Symantec annotations of the page elements

According to results, 10% of them recorded a very high satisfaction level of using the feature, 45% responded that they are highly satisfied with the elements, and another 45% of the participants revealed that they are at a moderate satisfaction level. The critical response is no one has selected the feature with no or little satisfaction. It indicated that all participants are satisfied with the features. Therefore, this obstacle can overcome through semantic web and semantic annotations of the context of page elements.

The next problem identified was information overload due to excessive sequential reading, and the solution given includes voice method to get the information more quickly. The result is showing in the pie chart in Figure 10.
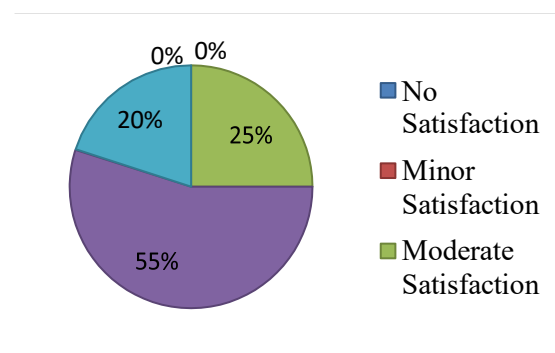

Figure 10: Responses for concurrent speech methods

According to the result, 20% of them chose the very high satisfaction level of using the feature, 55% responded that they are highly satisfied with the elements, and another 25% showed they are at a moderate satisfaction level. It indicated that all participants are satisfied with the features. Therefore, this obstacle can be avoided through concurrent speech methods. The next problem identified was content serialization. The pie chart in Figure 4.10 illustrates the satisfaction level of this feature by the visually impaired community.
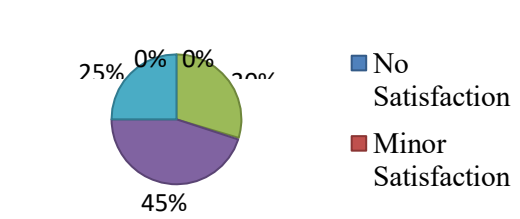
Figure 11: Responses for content serialization

According to the result, 25% of them reported a very high satisfaction level of using the feature, 45% responded that

they are highly satisfied with the elements, and another 25% showed that they are at a moderate satisfaction level. It indicated that all participants are satisfied with the features. Therefore, it can conclude that content serialization is an essential factor to consider in web navigation.

The next section mainly focuses on how navigation through specialized keys could affect the quick access to required information. The results are shown in the pie chart in Figure 12.
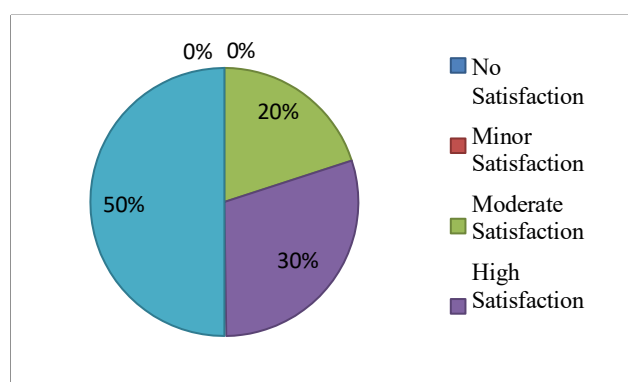

Figure 12 Responses for specialised keys

According to the result, 50% has a very high satisfaction level of using the feature, 30% responded they are highly satisfied with the elements, and another 20% showed that they are at a moderate satisfaction level. The critical response is none has selected this feature with no or little satisfaction. This indicates that all participants are satisfied with the elements. Hence, it is possible to overcome this obstacle by assigning special keys to the website to improve navigation.

Analysing the above results allows concluding that the visually impaired community needed the above-discussed features for an easy web navigation process.

5. Conclusion and Recomendation

The Phase 1 covers the solutions concerning the access limited by impairment issues. Various proposed solutions were tested here; i.e., ensuring the website is keyboard-friendly, ensure that all contents are easily accessible and support with Symantec annotation, add Alt Text to All Images (Alternative Text for images), Use headers to structure the content correctly, design all forms for accessibility, Do not use tables for anything except tabular data, Enable resizable text that does not break a website, Avoid automatic media and navigation, Create content with accessibility in mind, and Use best colour combination for Visually Impaired Community. All these considerations were tested with the participation of the visually impaired individuals.

The findings revealed that the visually impaired community must receive these necessities to increase the improvement of accessibility, and thus, these are essential

factors to overcome web accessibility issues of the community.

Phase II concerns on usability issues arising from lack of design considerations. This activity validates braille display (Braille Terminal) support and audio support designs. The result points out that audio support is a significant part of web accessibility due to vision difficulty. If the website provides a video without the help of audio, they are unable to acquire the correct information. Therefore, web designers and developers must consider pre-recorded videos with audio facilities. When considering braille support in web designing, it highlighted that the option does not directly impact visually impaired web users.

Phase III is concerned with the frustration of waiting until a visually impaired-friendly version is available; this issue can overcome by introducing a rating widget option. It was also evaluated by developing a website with the rating widget feature. Results concluded that this accessibility badge helps improve web accessibility among the visually impaired community. Hence, it is also considered as a significant feature to use in websites to overcome the web accessibility issues faced by the vision-impaired community.

Phase IV deals with the lack of communication issues in the requirement gathering and testing in website designing and development process. In this activity, the website is designed and developed with the involvement of using visually impaired users. It was further tested on how to relate its involvement with overcoming the disability digital divide. Results here detected a significant difference, and without the participation of this community in the web development process. It further revealed that visually impaired individuals must be involved in requirement gathering, during the user interface designing stage, and in testing accessibility. Also, testing only via accessibility compliance tools is not sufficient for this community to access a website.

Phase V is an in-depth study on solutions to overcome web navigation issues faced by the visually impaired community when they are accessed through screen reading software. The solution proposed to use the semantic web and semantic annotations of the context of Page elements, Content serialization, and navigation by special keyboard commands. According to the analysis of three web navigation aspects, respondents clearly stated that three of these aspects highly influence the effective web use and increase the satisfaction level of the websites accessing process. Hence, web developers must consider these three factors during website development, as they contribute to overcoming the web accessibility issues faced by the visually impaired community.

The findings revealed that the visually impaired community confront difficulties on web and mobile accessing. Therefore, the last recommendation is focused on the national level consideration to alteration of national level web guidelines that the web could follow. Therefore, a specific set of guidelines are recommended for web developers to apply in the web application design and development process.

Furthermore, these guidelines can be recommended as a benchmark in national level policy development. This framework concentrates more specifically on solving the

problems faced by the visually impaired community in Sri Lanka, and therefore, in national-level policy development to overcome digital divide process, it could be considered in border aspects to access the related problems and implement respective solutions.

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A Philosophical Axiom Review on "THE METHODOLOGY" of Computing Research

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Abstract: *Computer Science today spans an increasing range of theoretical and practical disciplines in its exploration of what can and cannot be automated, which is giving rise to a greater diversity of disciplinary collaboration. Where collaboration is between individuals from different disciplines then accommodations are needed in agreeing on a research philosophy and developing the research methodology. A review of the general research literature suggested that where research is undertaken by different disciplines misalignment between the respective understandings of the ontology, epistemology and axiology (o-e-a) underpinning the research is not uncommon. Studying the prominent literature, it developed an online mind map to illustrate such misalignment and opened to discussion. The mind map was constructively criticized by experienced researchers from multiple disciplines and able to enhance. In addition to consideration of the different forms of collaboration deployed by researchers – multi- disciplinary, inter-disciplinary, trans-disciplinary – conceptualisations of the problem/enquiry domain itself were examined, as too was the relevance of perspectives by non-research stakeholders, who may be critical to the uptake of research findings. The level and scale of complications entailed by research interventions in navigating complex situations suggest that the nature of o- e-a cannot be determined by any one discipline (i.e., the 'research as usual' ticket), but most probably will emerge through collaborative negotiation. The development of such processes has hitherto been marked by the transition from multi-disciplinary to inter-disciplinary research. Where research extends beyond and outside scientific disciplines (i.e., includes non-scientific sources or practice, engages with learning processes from wider society) – trans- disciplinary research – the challenge to academia is establishing whose o-e-a counts, that of the researchers, or that of the knowledge users? This paper explores these options.*

Keywords: *Complexity, interdisciplinary, Research Methodology, Ontology Epistemology Axiology*

1. Introduction

A. Computing research

The research agendas in computing science cover theoretical disciplines such as artificial intelligence, data analytics and information theory, and increasingly extend to the practical disciplines relating for example to cyber security, fintech, education, climate change and disaster management. All such extensions are inevitably informed by the other existing discipline-oriented theories and research philosophies.

B. Researching Complexity

Despite the undoubted successes of science and technology, and in particular computing science, the contemporary world is confronted with increasingly complex issues (e.g., climate crises, biodiversity loss, health pandemics, governance failures) that are not readily responding to conventional scientific approaches. Research responses have not only included deeper specialization within disciplines, but also greater diversification, as manifested in the growing collaboration between disciplines. (Pradeep & Morris, 2021)

C. Research Requirement

The initial objective of the study was to develop a comprehensive framework for expediting the selection and deployment of the most appropriate research approach/es for a given type of challenge. This was to be undertaken iteratively, and by drawing on the expertise of experienced researchers from different disciplines. It was felt that such a framework might be of particularly useful to research students and for senior academic colleagues charged with advising them.

In the process of advancing the study and engaging with the wider research community, it became apparent that the initial premise relating the research methodology with the philosophical axioms (i.e. ontology, epistemology, axiology), was not immutable, and that typically in complex situations the required methodology, over and above facilitating inter-disciplinarity, needed to enable the integration of scientific and academic knowledge with the different pieces of knowledge of the real-world, non-scientific, problem stakeholders.

D. Objective

These discoveries suggested that rather than the development of a tangible framework, the objective needed to be framed more in extending the mindset of researchers (i.e., from generating new scientific knowledge, to effecting real-world changes), through enhancing their awareness of and responsiveness to diversity of challenges, including

situations of complexity. While there will always be a need for natural or applied science solutions to those problems where a cause-and-effect logic applies, the growing incidence of complex situations requires more innovative and collaborative approaches, including in the field of computing.

2. Methodology

Drawing on 35 authoritative sources from different disciplines, an initial mind-map was developed (Figure 1) setting out the interactions between the philosophical research axioms of ontology, epistemology and axiology, research philosophy and methodology, formulation of the research questions/hypotheses, research design and its components, and following analyses and syntheses culminating in the generation of new knowledge.
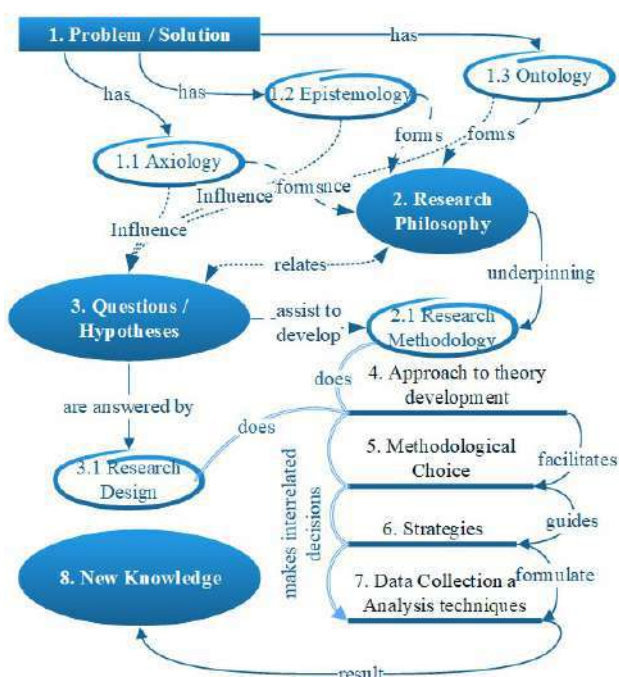

Figure 1. Initial mind-map
Source: (Pradeep, 2021)

Whilst conceived as an organizing framework for the exploration and development of research interventions, the mind map was intended to provide an entry point and fulcrum for discussion for members of the wider research community. The mind-map and explanatory notes were posted on an international research platform, with an invitation for comments. There were more than 500 reads and approximately 50 responses from a self-selecting cross-section of international researchers, a dozen of whom engaged more fully, which included providing references in support of their arguments. These contributions stimulated further reflection, giving rise to another iteration and sharing of the mind-map, but more significantly drawing attention to the centrifugal forces moving research from modest, zero-sum attempts at collaboration between different disciplines – multi-disciplinarity – through to integrative approaches between disciplines – inter-disciplinarity. Most

significantly they pointed to the ineffectiveness of much research in the face of increasing complexity impacting sectors dealing with societal and natural environments, due to a lack of meaningful collaboration with policymakers, practitioners, and civil society Fortunately, there is a rich and expanding literature on these challenges, which the study is reviewing and continues to draw on, to better identify key considerations and options for research interventions. It is hoped that this discussion paper might be used for/by research students, providing for a fuller understanding of the research challenge.

3. Results and Discussion

Whilst research proposals are amply littered with terms like multi-disciplinarity and interdisciplinarity, and increasingly trans-disciplinarity, all suggesting greater collaboration, they are often used rhetorically and interchangeably, with the nature of the collaboration seldom elaborated. Complexity is a ubiquitous feature of many of the problems impacting sectors dealing with societal and natural environments, which requires high degrees of collaboration. The conventional Newtonian paradigm, premised on physical entities being controllable, measurable, predictable and with a linear logic to equilibrium, and which may therefore be applicable to certain limited technological challenges, is of no use in addressing complexity. Complexity is characterized by many interacting parts, linkages dimensions and processes, and exhibiting non-linearity, unpredictability and emergence (Chambers, 2017). Within any complex system, there may well be non-complex problems (i.e., amenable to mono-disciplinary interventions), but the social and environmental uncertainties, disagreements and limiting capacities of stakeholders cannot be effectively addressed through a mono-disciplinary lens. Ideally, this requires a transdisciplinary approach in which researchers step outside their comfort zone (i.e., research as usual), and seek to blend different perspectives so as to understand scientific questions in their complexity. Trans-disciplinarity involves integrative research between scientific and non-scientific sources or practice, with cooperation among different parts of society, including academia, giving rise to new forms of learning and problem solving (McGregor, 2004)..

Recent studies of complex water problems in catchments in Southern Africa where millions of people may be adversely impacted, reinforce the idea that there is no single research approach that can constructively build on the many, diverse, and often conflicting worldviews and epistemologies held by catchment stakeholders from case study work and a review of the literature, Fallon, Lankford and Western (2021) identify a landscape of possible solutions based on four major dimensions: science, policy, practice, and participation (Fallon et al., 2021). A 'social learning' pilot in the Great Ruaha River catchment, where years of conventional research had failed to reverse the seasonal drying of the once perennial river, identified shortfalls in catchment governance, and specifically pervasive weaknesses in critical integration dimension (e.g. within and between sectors; of local people and the private sector; in

upstream-downstream working; in the devolution of climate change adaptation; and between practice, research and policy-making) (Morris & Chonya, 2016).

There can be no room for research that does not acknowledge or engage with these broader contextual dimensions. Worse, siloed research disciplines and the dominance of conventional research methodologies (i.e., empirical, interpretive, and critical), bound to their own notions of epistemology, ontology, and axiology, threaten causing a fragmentation of contemporary knowledge.

4. Conclusion

Academic ways of knowing have proven inadequate in the face of growing socio-ecological complexity. Whilst good research is undoubtedly being undertaken, slavish adherence to longstanding research methodologies (e.g., empirical, interpretive, critical) – the 'research as usual' approach – is undoubtedly limiting the applicability of much research to real-world situations. Academia generally but research students in particular need to be facilitated in understanding the implications of complexity, in recognizing the diversity of perspectives, and in respecting the plurality of knowledges, in their efforts to create a deeper, more effective understanding of reality.

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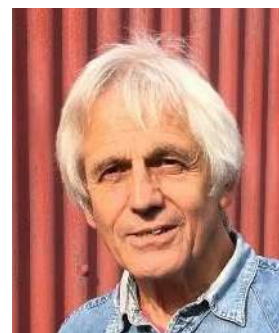
Mike Morris is an advocate and facilitator of systems approaches in addressing the challenges of complex – 'wicked' – issues. He has worked as a social development and governance adviser with WWF-UK (2007-2017), senior scientist with the Natural Resources Institute (1999-2006), country director and programme manager in Namibia and Sudan respectively, for Voluntary Service Overseas (1987-2005). Most recently he has lent support to WASH programmes in Ethiopia, Uganda, Kenya and Bangladesh.

Factors Affecting Undergraduate Students' Intention towards Digital Piracy of Software in Sri Lanka: with special reference to Undergraduates in Kotelawala Defence University

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Abstract *: The development of easy and affordable internet access has led to a growth of Digital Piracy of Software (DPS). DPS has resulted in losses to the Software industry and convictions for some of the people who practice DPS. Therefore, the author identified that it is important to find the factors that affect DPS from a digital consumer's viewpoint. The purpose of this study was to identify the factors that affect the intention of undergraduate students of Sri Lanka towards DPS. The theory that was used for this study is the theory of planned behavior. To reach the purpose of this study, a model was developed which included 4 independent variables: Attitude, social influence (SI), perceived behavioral control (PBC), moral obligation (MO) and one dependent variable (DV): Intention towards DPS. The population of the study comprised of undergraduates in Sri Lanka and non-probability sampling technique was used for selecting the sample for the study. Data collection for the analysis was done using a web- based questionnaire survey which resulted in a sample size of 165 responses. The collected data were analyzed using quantitative analysis techniques with the help of IBM SPSS software. In the analysis process, the reliability and significance of the data were checked first, and then the impact of independent variables on the DV was measured. The results showed that only the MO factor had an impact on IDPS of undergraduates of Sri Lanka from the four factors proposed by the author.*

Keywords: *Digital piracy, Software, Intention, Copyrights*

1. Introduction

Digital Piracy (DP) refers to reproducing, using or Distributing information products such as software, music, eBooks, and movies in digital formats without the consent or authorization of the legal owners of those products (Belle and Peitz, 2014). Digital piracy of software (DPS) refers to reproducing using or distributing software without the authorization of the product owners. License agreement of software states how that software can be used and distributed. Digital Piracy behavior goes against the guidelines of a software's license agreement. The noun pirate refers to a person who is committing Digital Piracy. In the context of this study, a pirate is a person that commits Digital Piracy. Operating System software like Microsoft Windows and Applications Software like Adobe Suite, Office Suite and IDM are examples for some software that are pirated by many people.

A. Background of the Study

Within the last decade, technology has been developing which resulted in fast and affordable internet connections. This has broken the physical barriers of the world and has made the world one cyber village. But this also resulted in digital piracy which is a big problem for copyrights. Digital piracy existed before the internet was easily accessible, but the development of better facilities for Accessing the internet has made the foundation for the sharing of digital products on a large scale. Since it is hard to create limitations for the sharing of digital products over the internet, those digital products started being shared over the internet against their copyrights. The efforts that the Digital product industry has taken against the act of Digital Piracy have not had an important impact on minimizing Digital Piracy. MarkMonitor.com, which is an internet security firm, selected 43 of the websites that provide digital material to be illegally downloaded and measured the number of visits per year, which was 53 billion (Xanthidis and Aleisa, 2012) . This goes to show that Digital Piracy is being used by a lot of people around the world.

Losses that digital product manufacturers have to face because of digital piracy have been growing throughout the last few years. According to the Business software Alliance (BSA), software piracy caused the highest annual loss in 2007 in USA which was \$48 billion. BSA also estimated that about 1 billion computers (Around half of all PC's) contained software that was not licensed, in other words, pirated software. BSA states that in 2011, the global piracy rate was at 42% and the commercial value of software theft was \$63.4 billion. In 2011, it has been found that pirates in emerging economies install more pirated programs per PC than pirates in mature markets (Business Software Alliance, 2012).

Sri Lanka is a country with an emerging economy in the software market. So, digital piracy of software has an effect

on the software market of Sri Lanka that results in losses for the software manufacturers in Sri Lanka who manufacture targeting the local market. Online Piracy of Software has a negative effect on the Software manufacturers whose target market is the Global market, resulting them in losing some nu of potential sales and customers. Software manufacturers all over the world suffer from financial losses that are caused by the act of digital piracy of software. Therefore, against this background, the researcher is prompted to investigate and find out the factors Affecting people's Intention towards the Digital Piracy of Software in Sri Lanka.nka.

B. Research Problem

Business Software Alliance states that Sri Lanka is a country with an emerging economy (Business Software Alliance, 2012). People who are in emerging technologies are the majority of the people who use digital piracy in the world (Arli, Tjiptono and Porto, 2015). Considering these situations, the number, and the diversity of studies on piracy behaviour in Sri Lanka seems to be lacking.

C. Research Question

What are the factors that affect undergraduate students' Intention towards digital piracy of software in Sri Lanka?

D. Research Objective

To identify the factors that affect undergraduate students' intention towards digital piracy of Software in Sri Lanka

E. Importance of this Study

Since Undergraduate Students are a portion of the lost potential customers of software due to digital piracy, this study is important in identifying factors that Influence digital piracy of software. These factors can be important to the software industry for identifying the factors that affect their sales losses.

F. Research Scope

The study focuses on software from the digital products that are pirated. The scope of this study is limited to undergraduates in Sri Lanka due to practical limitations and time constraints. The rationale for selecting undergraduates is, because they have become a large portion of software users. To sum up, this study is concentrated on undergraduates' intention towards digital piracy of software in Sri Lanka.

2. Literature Review

3. Digital Piracy of Software

Digital piracy is a vast area and it can be looked at from different angles. The main 2 angles are the industry's viewpoint and the consumers' viewpoint. There is a clash between the interests of the above-mentioned viewpoints. This clash has resulted in financial losses for the industry and legal problems for pirates (People who practice digital piracy). As an example, a website named gamato.info which was a website with torrents (peer-to-peer files) was shut down and its administrators were imprisoned in

Greece. Digital Piracy affects different categories of digital products such as Software, Movies, Music, and eBooks. There is main 3 types of people or organizations that participate in the act of Digital Piracy. They are, Organizations or people who distribute pirated products for commercial gains, Organizations or individuals who distribute pirated products without expecting any commercial gain and individuals who consume digitally pirated products. The consumption of these products can be done through the internet or other means like USB drives, CD's, and DVD's (Xanthidis and Aleisa, 2012).

This study will use the viewpoint of the consumer for identifying the Factors that Impact digital piracy behaviour and will select software as the digital product of focus throughout the study

4. Theory of Planned Behaviour (TPB)

Ajzen (1991) proposed adjunct of the "Theory of Reasoned Action" called the "Theory of planned Behaviour" (TPB) which is broadly used in several various fields to clarify intention and behaviour (Taima, Robin and Nathalie, 2019). Three suggested factors of the TPB model affecting on intention and behaviour of a person consist of attitude, subjective norms, and perceived behavioural control. Based on the theory of planned behaviour and previous literature, three core factors could be summarized which impinge on digital piracy named, attitude towards behaviour, environment influence and social influence. These three categories could be utilized to predict consumers' digital piracy behaviour in this context (Pham, Dang and Nguyen, 2020).

5. Factors Affecting Intention towards Digital Piracy

1) Attitude: Attitude is what gives meaning to the feelings of an individual with respect to a particular behaviour. These feeling could be happiness, relaxation, pleasure, discontentment, and distaste. Attitude has been acknowledged as the main construct in social psychology. Through studies, it has been found that Attitude has a big impact on intentions of individuals based on the Theory of Planned Behaviour (TPB). In Malaysia, attitude has a positive relationship with digital piracy behaviour among undergraduate students meaning when there is a positive attitude towards digital piracy, the digital piracy behaviour increases (Kassim and Kasuma, 2017). Among the majority of Asians commencing digital piracy has become an accepted act because they have an easy-going attitude towards it than Americans .They tend to duplicate software material, buy illegal pirate material and not criticize those who do so (Arli, Tjiptono and Porto, 2015).

2) Social Influence (SI): Social influence can be explained as how other people of the society influence convictions, emotions, and behaviour of a person. People gain social influence through observations, perceptions and expectations about a decision made by others. Social class,

culture and subculture are important sub factors that affect social influence. There is significant and positive relationship between social influence and digital piracy behaviour. When the social influence increases, the digital piracy behaviour will also increase (Kassim and Kasuma, 2017).

3) Perceived Behaviour Control (PBC): Perceived Behaviour control can be stated as the level of control or easiness of action depending on his/her capability or technology. PBC has a strong impact on intention towards Digital Piracy. (Pham, Dang and Nguyen, 2020)

4) Moral Obligation (MO): Moral obligation can be defined as the personal perception about whether an action is considered right or wrong. (Pham, Dang and Nguyen, 2020)

3. Methodology

To delve into the purpose of this study, the researcher proposed a conceptual framework based on peer-reviewed research articles and developed four hypotheses by reviewing existing theories. Inductive and deductive are two types of research approaches. The inductive method goes from more specific to more general, which is developed a theory during the survey process. The deductive approach goes from more general to more specific. Quantitative researches highlight data perfection than qualitative research ((Taima, Robin and Nathalie,2019). Accordingly, it is convenient to analyse data in quantitative method. Moreover, the quantitative method can aid to construct reliable clarifications and assist to make correct and faithful comparisons. Hence, deductive approach was used for this study with the quantitative method. ding (2012) stated that non-probability sampling can be used when it is the choice of participating in the survey is left up to each individual. The population of this study comprised of undergraduates in Sri Lanka where the sample size was selected according to the non-probability sampling technique considering convenience to reach sources and time constraints. Sample size is usually determined from the following equation: $n >= 50 + 8m$, in which n equals to number of variables used in the model. In this study, there are 4 variables. So, the minimum size of the sample must be 82. Further, online questionnaire survey, which included five demographic questions and twelve Likert scale questions were utilized as research technique in this study.

Based on the web-based questionnaire 165 responses were collected as primary data to generate useful information through analysis. The researcher initially carried out a pilot test with 20 respondents to ensure the items used in the questionnaire were reliable and appropriate. Results acquired from the pilot test were used in addition to improve the final questionnaire. Finally, gathered data was

analysed using IBM SPSS software. During the process of analysis to achieve the research purpose, reliability, validity, correlation and multicollinearity of data were checked.

A. Conceptual Framework

Based on peer-reviewed studies on digital piracy, this study proposes a conceptual framework showing factors affecting intention towards digital piracy of software suggested by previous authors. Kassim and Kasuma (2017) have found that attitude and social influence affected the digital Piracy behaviour among undergraduate students. Arli et al. (2015) stated their findings show that Attitude towards software piracy positively affected software consumers' digital piracy behaviour. Moreover, Pham et al. (2020) has shown that perceived behaviour control strongly influences the intention to pirate digital products through their study. Further, Pg and Rmmd (2017) state that attitude and social influence positively affected the intention of students' intention to use pirated software in Sri Lanka while moral obligation had a negative effect on it.
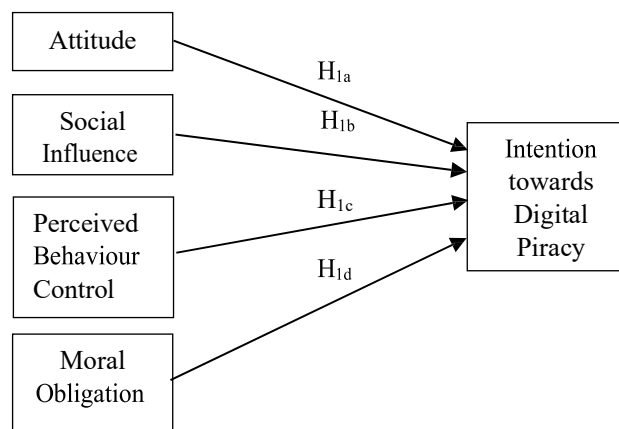

Figure 1. Conceptual Framework
Source: Author (2020)

According to the conceptual framework illustrated in Figure 1, Attitude, SI (social influence), PBC (perceived behavioural control) and (MO) moral obligation were independent variables (IV) and intention towards DPS (digital piracy of software) has been considered as the dependent variable (DV). Corresponding to Figure 1, four hypotheses were developed in order to conduct the research.

H_{1a}: Attitude has an influence on undergraduates' intention towards DPS
H_{1b}: Social Influence has an influence on undergraduates' intention towards DPS
H_{1c}: Perceived behavioral control has an influence on undergraduates' intention towards DPS
H_{1d}: Moral Obligation has an influence on undergraduates' intention towards DPS

4. Results

With respect to identifying the factors affecting DPS, some demographic characteristics were analyzed in the questionnaire in order to present information in a conspicuous method. The majority of responses were from the computing faculty (58.8%), from the total 165 responses while 18.2% account for engineering faculty. The half portion of respondents were male respondents (50.9%). Out of the 165 respondents, 97% of them have their own internet connection to get in touch with new technology. The most significant finding from the results of the demographic questions was that almost all the respondents (99%) have a personal computer. Finally, to identify the factors influence on DPS, Likert scale questionnaire was analyzed using 'IBM SPSS (Statistical Package for the Social Sciences) Version 21'.

A. Reliability Test

The Cronbach Alpha is used to determine the level of reliability of the collected data and the study. To have a greater reliability, the value should be greater than or equal to the accepted level of 0.6.

Table 1. Reliability Test

Variable	Cronbach' Alpha	No of items
Attitude	.701	3
SI	.715	3
PBC	.063	3
MO	.699	2
DV	.839	3

Source: Author (2020)

According to the Table 1, Cronbach alpha is greater than 0.6 for all independent variables and the dependent variable, which indicates the greater reliability of studied constructs (variables).

B. Validity Test

To validate research instruments the Kaiser-Meyer-Olkin (KMO) test and the Bartlett's test was used. KMO and Bartlett's Test value exceeded the accepted level of 0.5, indicating greater validity of the study.

Table 2. Validity Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.785
Bartlett's Test of Sphericity	Approx. Chi-Square	352.369
	df	10
	Sig.	.000

Source: KMO Output - IBM SPSS Statistics Viewer 2020

C. Pearson Correlation-Relationship between independent variables and dependent variable

Pearson correlation is used to calculate correlation between independent variables and dependent variable. It ranges between -1 and +1. +1 implies positive relationship while -1 sign implies negative relationship. And 0 value or very close to zero, implies no linear relationship so it means uncorrelated.

Table 3. Correlation Test

	Pearson Correlation	Sig. (2-tailed)
Attitude	.412	.000
SI	.458	.000
PBC	.478	.000
MO	.621	.000

**. Correlation is significant at the 0.01 level (2-tailed).

Source: Author (2020)

As Table 3 shows, all the variables indicate (+) positive correlation. Moreover, MO (moral obligation) scored the highest Pearson correlation coefficient (0.621).

D. Model Summary

Model summary interprets the strength of the relationship between the model and the dependent variable. R, multiple correlation coefficient determines the correlation between independent variables and dependent variable. R^2 which is known as the coefficient of determinant describes at which amount, dependent variable is measured by the independent variables or in other ways, it explains the proportion of variance in dependent can be explained by independents. Adjusted R^2 is known as the adjusted coefficient of the determinant. R^2 value should be straightforward, and it should always stand between 0 and 1.0. Standard error in the model summary reveals how much the mean of the sample deviates from the mean of the population.

Table 4. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.645[a]	.416	.402	.600

a. Predictors: (Constant), MoralObligation, Attitude, PerceivedBehaviouralControl, SocialInfluence

Source: Regression Analysis Output - IBM SPSS Statistics Viewer 2020

According to Table 4, R value shows 0.645 correlation with dependent variable. Adjusted R^2 is 0.402, which indicates independent variables explain 40.2% of dependent variable. In other way it suggests regression model is significant.

Further, it suggests that the variance of independent variables determines a value of 40.2% for the variance of intention towards DPS.

E. ANOVA- The Impact of Independent Variables on Dependent Variable

ANOVA (Analysis of Variance) is used to test the overall match of the model (developed conceptual framework). F value and p-value (Sig) can be used to predict whether hypotheses are accepted or rejected. Accepted sig value, p-value<0.05.

Table 5. ANOVA

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	41.089	4	10.272	28.521	.000[b]
	Residual	57.627	160	.360		
	Total	98.716	164			
a. Dependent Variable: IDPS						
b. Predictors: (Constant), MoralObligation, Attitude, PerceivedBehaviouralControl, SocialInfluence						

Source: Regression Analysis Output - IBM SPSS Statistics Viewer 2020

According to Table 5, p-value (sig) is 0.000, which indicates at least one of the independent variables has influence on intention towards DPS. That means at least one hypothesis is accepted. Hence, the researcher can proceed to test hypothesis individually. Further, having F-value of 28.521 proves the significance of the relationship at confidence level of 95%.

F. Coefficient Table

This is another output of regression analysis which interprets the standardized beta coefficients that interprets the relative importance of independent variables on the dependent variable.

As Table 6 shows, MO has a 0.000 sig value where p-value<0.05. So, it is significant. Except MO, all other independent variables sig value is more than 0.05 and they are insignificant. Attitude, SI, PBC and MO have (+) positive beta coefficient values. That indicates a predictor variable with a coefficient value between 0 and +1, portraying a positive effect on the dependent variable. Attitude has a beta coefficient value of 0.123 which indicates if the other independent variables were held

constant, attitude would increase by 1, then intention towards DPS would increase by 0.123. Similarly, all other independent variables will change.

Table 6. Coefficients

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.660	.192	[16]	3.438	.001
	Attitude	.126	.076	.123	1.650	.101
	SocialInfluence	.056	.103	.052	.547	.585
	PerceivedBehaviouralControl	.114	.098	.108	1.166	.245
	MoralObligation	.472	.082	.468	5.763	.000
a. Dependent Variable: IDPS						

Source: Regression Analysis Output - IBM SPSS Statistics Viewer 2020

G. Hypothesis Testing

Table 7. Hypothesis Testing

Independent variables	Standardized coefficient Beta	Sig(p-value)	Decision
Attitude	0.123	0.101	Rejected
SI	0.052	0.585	Rejected
PBC	0.108	0.245	Rejected
MO	0.468	0.000	Accepted

Source: Author (2020)

To test hypothesis p-value was used. Taima et al. (2019) states that the significant level for p- value is 0.05. If the significant value for a variable is more than 0.05, it is not supported

H_{1a}: Attitude has an influence on undergraduates' intention towards DPS.

Sig value of attitude, which is 0.101, is higher than significant level of 0.05. So, H_{1a} is not supported, that means H_{1a} is rejected.

H_{1b}: Social Influence has an influence on undergraduates' intention towards DPS

SI shows a sig value of 0.585 which is higher than accepted level of 0.05. H_{1b} also not supported. It is rejected.

H_{1c}: Perceived behaviour control has an influence on undergraduates' intention towards DPS

0.245 is the sig value that is shown for PBC. That means H_{1c} also not supported. It is rejected.

H_{1d}: Moral Obligation has an influence on undergraduates' intention towards DPS

MO has a sig value of as 0.000. Which is lower than sig level of $p<0.05$. So, this is supported and accepted.

5. Discussion

The main objective of this research is to understand the factors that could affect the intention of undergraduate students towards Digital Piracy of Software in Sri Lanka. In order to achieve this, a model was proposed using the TPB and previous literature which included attitude, SI, PBC and MO as the independent variables and intention of undergraduates' towards DPS as the dependent variable. The model summary and ANOVA suggests that the relationship between the model and the dependent variable is significant, $F_{(4,160)}=28.521, p<.001, R^2=.402$. Statistics show that Attitude, SI and PBC have sig values (P-values) smaller that the significant level value which is 0.05 while MO has a sig(P-value) bigger than 0.05. These statistics express that only MO has an influence on undergraduates' intention towards DPS whilst Attitude, SI and PBC do not.

A non-probability sample was used in this analysis and a minimum of 82 responses were required. So, the 165 responses used in the analysis can be considered as an acceptable sample.

6. Conclusion and Reccomendations

Over the years, many studies have been done on the topic of piracy. Some of them have attempted to find the factors that affect Piracy behaviour. Attitude, awareness, religiosity, social influence, computer experience, digital media cost and moral obligation are some of the factors those studies have found out. The TPB was the theory that was used for this study. Its main suggested factors are attitude, subjective norms and perceived behavioural control. Based on previous findings and the TPB the author proposed 4 factors that could affect the intention of undergraduates in Sri Lanka towards DPS which are attitude, SI, PBC and MO. According to the results of the quantitative analysis of this study, attitude, SI and PBC have sig values (P-values) smaller that the significant level

value which is 0.05 while MO has a sig(P-value) bigger than 0.05. These values suggest that attitude, SI and PBC do not have a significant effect on undergraduates' intention towards DPS. The only factor among the considered factors that has a sig(P-value) bigger than 0.05 is MO. This suggest that MO has a significant effect on undergraduates' intention towards DPS.

As this study covers the intention of undergraduates' towards DPS, further studies can be conducted on different populations such as employed adults. Also, the scope of this study can be further expanded to include two or more categories of digital piracy such as movies, music, and eBooks.

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A Review of Personality of Interaction and Cross-Cultural Applicability of User Evaluation Methods

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Abstract: Importance of a designed artifact must constructively promote the brand and aid in creating favourable brand experiences. A recent area of interface design that is essential for designers from many disciplines is culture-based user interface design. This review compares user evaluation methods' cross-cultural applicability and personality of interaction with the simple beauty of a comprehensive understanding of the user experience. Basic Methodology Comparative analysis is what is contributed and implications this study should help. It implies that these are the results of ingrained cultural disparities in how people interact with one another. 87% of the studies evaluated for this analysis came to the conclusion that cultural variations do in fact affect user experience and user interface.

Keywords: Interaction, Personality, Experience, Culture, Branding

1. Introduction

Practicing designers have some connection to branding. Interviews with knowledgeable practitioners demonstrate that while there is evident application of visual branding expertise to the visual form of interactive objects, there are no systematic ways to create an interaction aesthetic to complement a brand. Without an interface, no corporate visual communication is complete, but businesses are no longer content with websites that only look nice. They must now put in extra effort to meet the cultural needs of users, keep them using the computer product for as long as possible, and ensure that they comprehend the material. These objectives will only be met by the computer product with a well-designed user interface based on culture.

Interface localization is becoming increasingly widespread as businesses promote their software internationally and try to capture the global e-commerce market. Although localization is frequently thought of as primarily a translation Endeavor, it is now evident that language is only one aspect of making a product suitable for usage in a foreign cultural setting. In order to grasp the meaning of experiences in context, user experience (UX) research has either adopted an interpretive approach or a more general
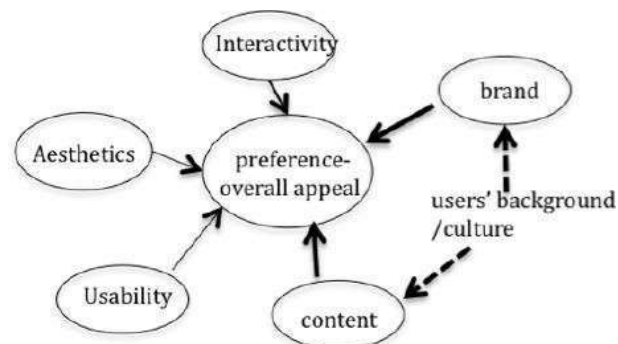

Figure 1. Summary of influence of website qualities on overall judgement/preference

method that looks into the psychological components that support user experience.

Users' attitudes toward brands can influence both pragmatic and hedonic aspects of judgement, with negative attitudes toward brands having a negative halo effect on other design qualities, and positive brand attitudes having the opposite effect. The brand is known to have a strong influence on users' preferences for websites. ' Bolchini et al' demonstrated a similar halo effect between enhanced usability and consumers' perceptions of brand image in websites. The influences of culture on interactive product design have a long history, however, the design implications are typically on a high level, such as techniques for analysing cultural variations in task performance.

2. State of Art

The research in various scientific fields, such as cognitive psychology, social psychology, and human-computer interaction studies, where the first impression was considered as a basis for forming general opinions about an object and the subsequent behaviour towards it, showed the significance of the phenomenon known as first impression. According to this field's research, first impressions are formed quite quickly.

Culture will affect how people engage with computers in the same way that it affects how people interact in general. A suitable approach must be given to embrace internalization in order to do things correctly because
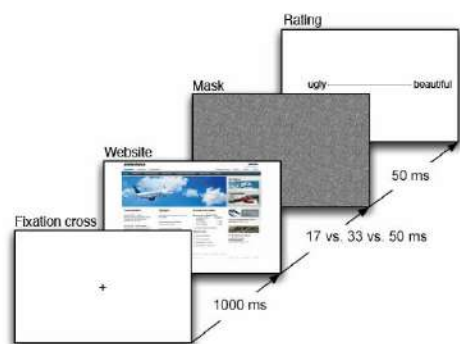
Figure 2. Aesthetic perception of websites: the impact of visual complexity, prototypicality

culture-based interface design issues are a component of computer product design. Aspects incorporated into the software development cycle methods. Utilizing interactive systems for task performance calls for interaction between the user and the system. People pick up thought, behaviour, and communication while residing in a particular social setting, typically characterized by country culture. As a result, a person's communication choices and behaviours are somewhat determined by culture. A person's communication style, which reflects how they transmit and receive messages, serves as a representation of a culture's overarching norms and values.

3. Related Works

Each interactivity attribute was examined using a collection of web-based studies that were presented in random order. Value-based design, for instance, has generated a great deal of interest in user-centred design. In order to improve designs that value people, Friedman's (2008) method elicits users' thoughts and sentiments regarding goods and prototypes. Although few interactive features were found besides social feedback features, perceived interactivity as a construct made up of connectedness to other users, responsiveness and user control has been shown to be related to measures of efficiency, enjoyment, trust, and loyalty in e-commerce sites.

The significance of initial impression and its profound impact on subsequent judgments about a particular website became the subject of numerous studies in the last decade of Human Computer Interaction (HCI) research. Additionally, participants were able to recognize many elements that contribute to a web page's overall impression (Tuch et al., 2012b). The results thus point to humans' capacity to see and respond to such stimuli as web pages in a relatively short period of time.

Despite the debatable monetary importance of branding in the creation of interactive products, there aren't many publications on the subject. A method to extract brand values represented by personality traits from websites and

assess whether the attributes are effectively communicated is provided by Bolchini et al.

4. Discussion

Following a pilot study with 28 participants, there were enlisted 85 people were for the main study, largely friends and acquaintances with a fairly equal distribution of men and women. Participants were between the ages of 30 and 40 on average. Each sub-questionnaire was given to participants, but were unable to make them complete it. As a result, each attribute received between 72 and 85 responses for the overall study. Brand characteristics and interactive features are perceived subjectively and are influenced by the specifics of how our prototype is embodied and the users' cultural background. A small number of participants in our study come from nearly the same cultural background. As a result, we exhibit the information in a heat map form to give a rich and impressionist picture that can support many theories.

Multi-method evaluation of the user was used. This contained a pre-questionnaire where demographic information was gathered and individuals' cultural backgrounds and computing experiences were questioned. The participants were asked if they would be interested in registering at Directed during a task observation session. As they searched for information on the website, they were instructed to "think out loud". A final interview was conducted to get comments on the website evaluation. For either cohort, performance and preference had no correlation. C4L performed significantly better, and user feedback suggested that a straightforward design with easy navigation and sparse content would have worked better for the users' task of diet planning. Preferences were clearly different, so we argue that more comprehensive content and interactive features influence preference, whereas the browsing mode probably frames user choice. In contrast, a simpler design suits effective performance in a goal-directed information search task.

Over the years, scientists and artists have been interested in the question of what exactly comprises aesthetics or beauty, what makes things beautiful, and what results in a delightful experience. On the one hand, beauty was formerly thought of as an attribute of an object that gives the perceiver a joyful reaction. The so-called subjectivist view puts out the notion of the prominent role of a perceiver in opposition to this viewpoint, which is referred to as the objectivist approach. Anything can be considered beautiful as long as it appeals to the senses, and this varies on the individual. The interactionist perspective, which combines both ideas, is one of the logical extensions of these methods.

5. Conclusion

This study demonstrates that one-on-one observation techniques, which are frequently used in usability testing, may not be as suitable for consumers outside of North America. Various difficulties caused by other techniques were also discovered, depending on the culture. To fully explore the application of various user research methodologies, more study is required. However, when creating procedures and tools for cross-cultural user testing, researchers should take cultural differences into account.

Some arguments in the literature suggest that while designing user interfaces, objective culture should be taken into account rather than subjective culture. Others contend that the subjective cultural profile of the interface should correspond to the subjective cultural profile of the intended users and that subjective culture is equally as significant as objective culture. Additionally, using cultural models to control the subjective components of user interface design has come under heavy fire for being rigid and stereotypical. Through research, we hypothesized that the characteristics of interface design required to create interfaces that cater to high power distance, high uncertainty avoidance, masculinity, and short-term orientation would give all users a more culturally based experience than an interface created to cater to the opposing sides of these dimensions. The research's underlying hypotheses were translated ed into the projected rise in overall usability.

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Development of HydroGIS Model Development Framework: Research Methodological Perspectives

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Abstract: *The common problem of transdisciplinary research is the acceptable research methodology. The author was questioned with the same when developing a HydroGIS model development framework as it synthesises multiple disciplines. Hence the present work aims to systematically select the methodology options for developing research methodology for the research. For that, it carried out a comprehensive literature review to formulate how ontology, epistemology, and axiology axioms are aligned with the author's thoughts. Then utilising the "Heightening your Awareness of your Research Philosophy" tool and Burrell and Morgan's four paradigm approach it selected and verified the most suited philosophy. Based on such underpinning, it analysed the best-suited theory-building approach and formulated the research steps. Founded on those steps it comprehended the methodological choices available to the research design. Then analysing the findings, it systematically selected the research strategies for operationalising the research design. Finally, it could be able to identify the framework development is in the interpretivism philosophy and explains the subjectivistic truth which is axiologically experienced by the researcher. The deductive approach is identified as the theory-building approach, where the components of the framework are identified through the explanatory science approach while the design science approach verifies the findings. Due to this bidirectional shift, research needs to follow the sequential multi-phase approach of the mixed method. Further, it identified constructivist grounded theory, survey, document research, and Multi-Criteria Decision-Making tools are the best-chosen research strategies to operationalise the research design. Finally, this work demonstrates how to systematically select the research philosophy and formulate research methodology for transdisciplinary research.*

Keywords:*Ontology Epistemology Axiology, Interpretivism, Abduction, Sequential multi-phase approach of the mixed method, Constructivist grounded theory*

1. Introduction

A. Background

The present work based on the PhD research which attempted to understand the present status of hydro-GIS-stakeholder relations to guide the development of sustainable decision-making tools. Developing a building block framework is necessary to describe the top-level components in phenomena and their relations to explain such a situation to software professionals (Pradeep & Edirisuriya, 2021). Then PhD work expects to develop a building-block framework (hereafter framework), illustrating the current status.

Initially, it found that special attention was paid to calibrate and verify the discovered knowledge as the flood management research works have an inbuilt difficulty of verification. Then, early works show the verification is done through three methods such as (1) Comparison with observed data, (2) Comparison with another model, and (3) Expert judgement (Ford et al., 2019; Malalgoda et al., 2016, 2013; Molinari et al., 2018; Zhong et al., 2020). However, always researches recommended the expert judgment technique as the reliability of the outcome.

Then the foresaid PhD research's expected knowledge should be a clear explanation of the existing urban flood management scenario, hence it needed to develop a framework to explain all the interested components to software development. When consider those components, it found that those are laying in multiple disciplines such as hydrology, GIS, stakeholder management, flood management and computing. Further, as those disciplines need to be integrated in depths as the framework should clearly explain how and what data and process to be shared or keep independently when automations, the research become transdisciplinary work rather than multidisciplinary activity. Then the fundamental challenge in transdisciplinary collaboration is accepted research methodology for each discipline. Hence the initial attention to methodology development faced complexities due to diverse views, terminologies, practises and norms in methodology development. Therefore, it understood that the general discipline-oriented methodology does not applicable to transdisciplinary research.

B. Aim and Objective

Then aim of the present work is to demonstrate how it systematically select the methodology options for transdisciplinary research. Then the objectives of the present research are comprehensive literature review on research methodologies, identify the research options availed and select the appropriate technique.

C. Background study of Knowledge discovery

Hence, this chapter describes and reasons out the research methodology selections. The research philosophy clarifies the knowledge building approach and underpins all the research methodology choices, including strategy, data collection techniques, and analysis procedures (Burrell & Morgan, 1979, pp. 1–5).

Research is to discover knowledge. Due to various viewpoints and arguments on the terminologies, a mind map (DOI:10.13140/RG.2.2.13395.50721) was developed to demonstrate how different activities are involved in such processes by 35 using prominent sources on research theory. The mind map fired the research community and 12 experienced international researchers, representing multiple disciplines such as administration, economics, logistic, operational research, sociology, environmental science, medicine, education, architecture, and computing, critiqued the mind-map. With their reviews it developed the reviewed mind map as shown in. The meaning of 'knowledge' and its approach is subjective. This subjectivity can be explained by understanding the research's ontological, epistemological, and axiological stances. The ontology, epistemology, and axiology collectively form a research philosophy while they influence the development of research questions or hypotheses or a mix of both regarding the problem or the solution. As the research philosophy and questions/hypotheses originate from the same sources, both should be conceptually related. The research design is then formulated to answer those research questions, hypotheses, or a mix of both.

In contrast, the research methodology underpins the research's ontology, epistemology, axiology, and philosophy. According to Rowley (2002), the research design is referred to the logical coherent of data collection to conclusions as answers to research questions. The research methodology also explains the research plan, the same as the research design. The research methodology/research design guides the researcher to select the research strategy, data collection, and analysis methods (Scotland, 2012). However, selecting the methodological choices, strategies, data collection techniques, and analysis techniques are interrelated decisions. Finally, all these activities resulted in new knowledge. Therefore, as the new knowledge is based on the implemented methodology, any doctoral research should provide a valid research methodology (Malalgoda, Amaratunga, and Haigh, 2013).

2. Materials, Method and Discussion

A. Choosing the Research Philosophy - Interpretivism

This research needed to start clarifying appropriate philosophical continua. However, it examined the history of research concepts for more ground orientation. This section provides a brief historical preamble to general research assumptions and demonstrates how it systematically utilised available tools to select the most suited research philosophy.

1) Brief History: Two prominent diversities could be observed in research philosophies: Western thinking and Eastern thinking. Das (1952) stated that Eastern concepts are intuition, while Western's are postulation and need proof. Eastern philosophies are primarily practical, while Western ones are theoretical (Das, 1952, p. 631).

Having lived with Lord Buddha's philosophical teachings for 48 years, the researcher's axiological ontology is more positivistic and trust that only single truth exists regarding life. Nevertheless, the present research follows Western philosophy since the study problem is primarily a practical observation and research is conducted for academic qualifications.

Western philosophy has different thinking families. In history, the *Sophists* – people with gifted communication capability – believed no absolute right or wrong, but Socrates (469 -300 BCE) started arguing that absolute right and wrong exist (Rankin, 1983). Such *Socratic method* can be considered a modern Western philosophy cornerstone that believes in *Inductive* reasoning for knowledge. Further developments of the induction method were observed, such as the *Dialectic method* of Plato (427-347 BCE), *Four causes of knowledge* by Aristotle (384 -322 BCE), and *"Idola Tribus"* (The idols of the tribe) of Francis Bacon (1561-1626). It considered that Bacon's ideology had formed the inductive approach to the *scientific method*, posing the questions and seeking science-based responses.

However, Galileo Galilei (1564 – 1642) and other philosophers' rival thoughts of *Deductive* reasoning for knowledge discovery developed another branch. The knowledge is derived logically in deductive reasoning, considering the hypothesis or theory-based observations. Since then, many intermediate branches such as *abductive* and *retroductive* arose between the two poles of inductive and deductive reasoning. However, interestingly, all these ideologies are independent as ideas but practically interdependent in different dosages. Therefore, the present work focused on identifying the most suitable research philosophy.

2) The Philosophical axioms: The majority of the researchers fail to grasp that their research is firmly based on their own philosophy of knowledge, reality, and understanding. Knowingly or unknowingly, based on philosophy, a researcher gathers data and analyse to find knowledge. If the research has better axioms of philosophy, then the entire data collection and analysis activities can be strongly justified. The term axiom (Latin) refers to the commends itself as import, while the general axiom refers to a statement of self-recognition. Therefore, it is accepted that the philosophical axiom is a self-established truth that does not require interrogation as fundamental beliefs cannot prove (McGregor, 2018).

The research philosophy focuses on the beliefs and assumptions that influence knowledge development. Hence, initially, the present work attempted to evaluate them. These beliefs and assumptions are described mainly under two axioms; ontology and epistemology. However, the present research considered the axiology axiom (the individual perceptions) vital in urban flood management. As it is understood, these beliefs and assumptions affect the research journey (perspectives on existing knowledge/gaps and research works required) and cumulatively shape the new knowledge.

The ontology (theory of being) axiom describes the nature of reality in terms of human thought as the fundamental/basics/truth. Ontology has two ontological assumptions: (1) realism and (2) nominalism. In realism, the realist (a.k.o. positivist) believes such fundamental is independent of the human consciousness. In contrast, the nominalist (a.k.o. interpretivist) believes the truth is has a relationship with humans and finds multiple truths. Epistemology (theory of knowledge) axiom refers to the acceptable and legitimate knowledge among the humans or community. There, the research beliefs are evaluated against the accepted knowledge. Then axiology axiom – the researcher's values to the research - is essential as the researcher is subjective and not independent from the problem (Malalgoda, Amaratunga, and Haigh, 2013; Johnson and Duberley, 2000, p.78; Berryman, 2019; Crotty, 1998).

The main research problem with the present research is an "unknown situation and interdependent research beliefs are arranged according to assumptions, as shown in Table 1.

Table 1: Ontological, epistemological, and axiological axioms of the research

Beliefs in the research	Assumptions		
	Ontology	Epistemology	Axiology
1. Water Flows from high ground to low	√		
2. A flood is a natural event of excessive water	√		
3. Human take actions to their own benefit only	√	?	
4. Humans change the water paths	√	?	
5. Forceful change of water paths unbalances the nature	?	√	
6. Flood in unbalance nature harms humans		√	
7. Flood water can be managed and simulated with hydrological modelling		√	
8. Flood water management should facilitate human needs		√	
9. Flood management decisions that do not align with human needs will not be practically implemented		√	
10. Flood management decisions should satisfy both the humans and nature to become sustainable decisions		√	
11. Such sustainable decisions are complex but are efficient decisions		√	
12. Automated tools should be used for such efficient decision-making		√	
13. Such tools should provide scenario-optimisation capability		√	
14. Proper water and human integrated models should be utilised to develop efficient tools		?	√
15. A model development framework should be utilised to develop such models		?	√
16. System Developers must construct and practise such model development frameworks			√

According to the explanations of Table 1, the ontological believes of water and human behaviours (Srl. no 1 to 4) have been well understood for centuries and accepted without conflict. However, apart from the truth of water flow from high ground to low ground, the other three beliefs can be considered socially-constructed multiple truths. Those beliefs are primarily with the nominalism stance. However, the epistemological beliefs of the present research (srl no. 5 to 13) are well accepted, and most flood management stakeholder research utilises them to continue their works. Nevertheless, the axiological assumptions (srl no. 14 to 16) are yet to be explored to greater extents, and the underpinning is totally value-laden to the researcher. In line with the understood epistemological, ontological, and axiological phenomena, the present research is socially constructed and value-laden research. It must select the best suited theoretical research philosophy to decide the exact research steps. The main intention of the present research is to understand the present situation and develop a framework to demonstrate it, which will facilitate building the flood management models with the best mix of stakeholders.

This framework attempts to illustrate the complex integrations of scientific and management needs of flood management with the complex stakeholder perceptions. Hence, this situation cannot be theorised or explained using existing principles, laws, or theories. The philosophical perspective of the present research is mainly with the ontological interpretivist stance, which facilities researchers to sense the research environment for explanations. Such explanation, in line with present research, will generate how the new framework to be demonstrated with the stakeholders.

B. Select Research Philosophy

The ontological, epistemological, and axiological understanding of the problem suggested that the present work's research stance is interpretivist. Then it took actions to confirm the theoretical justifications through practical approaches. It revealed that some terms used interchangeably for philosophy as extremes and paradigms. As these terms are utilised in very individual scenarios to broader views, the following subsections show how the present work selected the suitable philosophy for current

research considering five philosophies, two sets of extremes, and one paradigm approach.

1) Select the Research Philosophy: The present work initially utilised the Sumner and Tribe (2008, p. 59) classification table to determine the philosophical research directions by selecting the best-suited tendencies for epistemological assumptions (Table A-1). According to the finding, the present research is epistemologically positioned between Relativism and Realism but rejects Positivism.

Table A-1: Present research epistemological assumptions

Epistemological Assumptions	Selected Tendency	Author's reasoning
What is reality?	Multiple realities could be experienced.	The ontological phenomena as described above.
What is the aim of knowledge enquiry?	To describe reality. It is not possible to establish the truth about reality.	Analyse the existence to the present in a clear platform. Further, it is possible only to argue the best method, but it is impossible to prove it.
How does the researcher relate to the research?	The researcher is subjective and not independent of the research.	The researcher is a professional in Information Systems, which is part of the research domain.

Source: (Adopted from Sumner and Tribe, 2008, p. 59) The Sumner and Tribe classification produced mixed results (Table A-1); hence the present work employed a prominently utilised tool for PhD studies, the "Heightening your Awareness of your Research Philosophy (HARP)" reflexive tool. Alexandra Bristow and Mark Saunders developed this tool to clarify individual research philosophy (Saunders, Lewis, and Thornhill, 2019, pp.161–164). Table A-6 presents the filled HARP, and Figure A-1 illustrates the result. According to the HARP, the present research predominantly has an Interpretivism philosophy with a bias to critical realism and pragmatism.
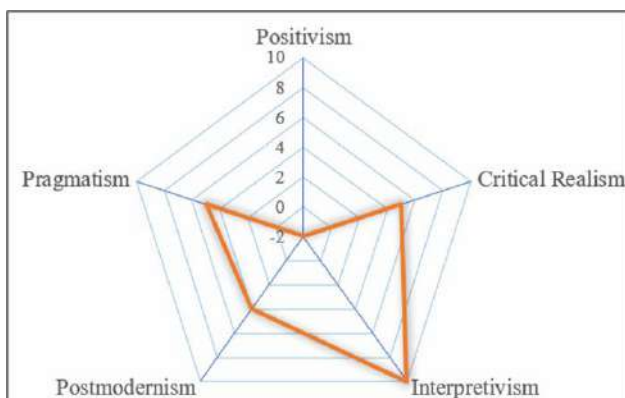

Figure A-1: Web of HARP Results
Source: Author

A1.1.1 Extreme 01 - Objectivism and Subjectivism:
Niglas (2010) described that research philosophies are scattered across multidimensional sets of continua from objectivism to subjectivism, based on the research discipline. According to Burrell and Morgan (2016, p. 3)'s explanation, ontologically, the objectivism approach embraces more *realism* while subjectivism embraces *nominalism* (aka *conventionalism*). When philosophy is at the extreme end of objectivism, the beliefs count the social objects the same as the independent natural objects. Then research is conducted the same way the natural researchers are carrying out, believing that truth exists independently from any. Concomitantly, when research is in the extreme form of objectivism, it believes that the truth is a created concept that depends on single to multiple people, specifically no real truth underneath. However, in a less extreme perception of objectivism, aka *social constructionism*, the research constructs the truth intersubjectively. Then the developing truth is enriched with the opinions, comments, and critics of the social actors and their own beliefs and values. This form of own values cooperation is called *radical reflexivity*. Table A-2 presents the objectivism and subjectivism continua summarised according to the beliefs.

Table A-2: Philosophical Continua with two sets of extremes

Type	Philosophical Continua				Present work
	Objectivism		Subjectivism		
	The extreme form	Less extreme form	Less extreme form (Social constructionism)	The extreme form (Nominalism)	
Ontology	One truth exists external to all available subjects	Truth is external from social actors	Truth is nominal and creates socially and intersubjectively	Truth is nominal and socially constructed	One truth regarding the water; but in management, social constructioni
Epistemology	Adopt assumptions of the natural scientist and truth is measurable Decisions based on Facts, Numbers and Observable phenomena, Analysis are law-like generalisations		Adopt the assumptions of the arts and humanities. Decisions based on Opinions, Written, spoken and visual accounts. Analysis of individuals and		The scientific reasonings of the floods (few) are measurable, but human causes (more) are qualitative
Axiology	As truth is independent, no value to the researcher or participants		The truth is Value-bound with the researcher and participants. *Radical Reflexivity* (incorporation of such to build knowledge) is observed		Radical Reflexivity is required

Source: (Adopted from Saunders, Lewis, and Thornhill, 2019, p.135)

A1.1.2 Extreme 02- Regulation and Radical Change perspectives:

Philosophies can be divided into two extremes based on political and ideological orientation (Burrell & Morgan, 2016, pp. 16–19). When the research discovers new directions based on the status quo, the research is with *Regulation* philosophy. Nevertheless, if the research provides the real solution to the problem that needs to change the status quo, then the philosophy is *Radical Change*.

As the present research believes the status quo is enhanced to add knowledge, the work is more aligned with regulation perspectives.

A1.1.3   Research Paradigm Approach:

According to Burrell and Morgan (2016, p.22), different extremes can be incorporated to develop scenarios for a clear understanding of the continuity and separation of philosophical concepts. The present work used Burrell and Morgan's four paradigms, as shown in Figure A-2.
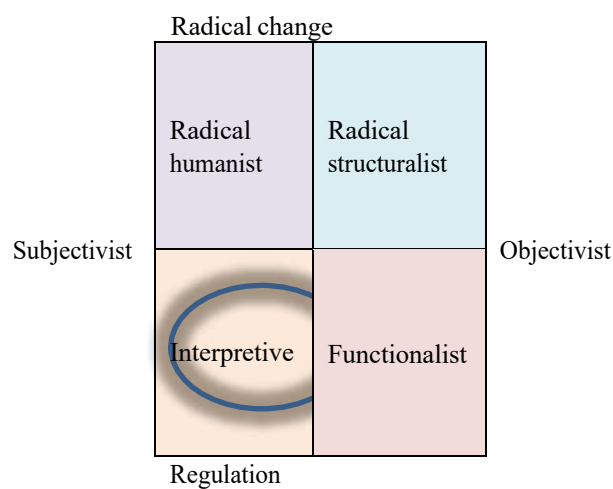
Figure A-2: Burrell and Morgan's four paradigms
Source: (Adopted from Burrell and Morgan, 2016, p.22)

According to the two extremes described above, the present research has subjective and regulation extremes. As per Burrell and Morgan, the suited paradigm is Interpretive, where the research should sense the outside world under a humanistic perspective with the flavours of multiple subjectivities. Kelemen and Rumens (2008) state such research must explain what is going on rather than changing the existence.

A1.1.3.1 Selected Research Philosophy

The present work compared the available research philosophies and explored the philosophical standpoint during this analysis. Table A-6 describes that interpretivism (10 points) achieved the highest rank and outstanding scores. The results of two extremes (Table A-2) and paradigm analysis (Figure A-2) confirmed this, and Figure A-3 presents the findings' highlights.

Figure A-3: Outputs of philosophical axiom finding
Source: Author

Accordingly, it would be possible to select interpretivism as
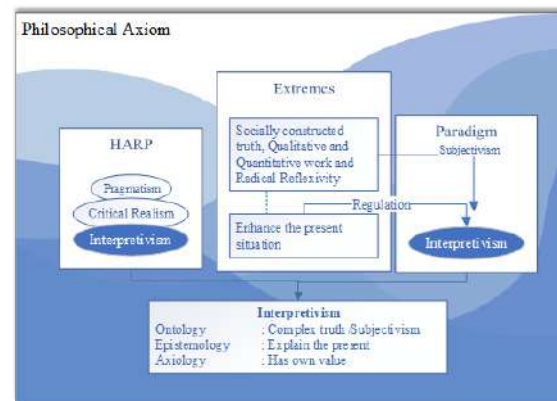
the philosophy of the present research logically. As per the accepted philosophical explanations, the ontology of interpretivism is a phenomenon in that reality is being seen as a complex and socially constructed scenario. Further, it considered that the personnel and people interpretation significantly influence such a scenario. Hence, evaluating the diversified meanings, processes, experiences, and practices is necessary. The epistemology of interpretivism is to have a different perspective or novel explanation of reality through the available theories. Then the axiology of interpretivism has a crucial role as the own interpretations and values make more meaning in knowledge debate (Jakubik, 2021).

A1.2   Choosing an approach to theory building - *Abduction*

Once it achieves the philosophical clearance, the next step is to select the approach to theory building.

A1.2.1   Theoretical explanation on theory building

As per the brief history provided, there are two fundamental approaches named *deductive* and *indicative* in theory building. The prime research approach of human thinking is hypothesis-based, i.e., the man predicts the results and carry out the actions. When this thinking maps to the research, it is named *deductive* approach that attempts to match and prove a theory or hypothesis using the research findings. Conversely, in the *inductive* approach, the philosophers discover the theory through data analysis. When it conceptually evaluates these two approaches, the deductive approach divides the whole reason into parts and evaluates, and the inductive evaluates the parts and accumulated to an entire reason (Munro, 1850).

Peirce (1960/1979) introduced *abduction* as the intermediate inference by deviating from both inferences. Abduction explains the situation with a provisional hypothesis that invented surprising phenomena. The inductive and deductive approaches are accumulatively practised in abduction (Flick, 2018; Peirce, 1960, p. 1160). Hence, this becomes an interesting theory-building approach to the present work.

A1.2.2 Practical selection of theory building approach

However, the induction theory building approach always opts for the interpretivism research philosophy. When implementing such an idea to achieve the research objective

of the present work - the development of explanatory HydroGIS model development framework (so-called new theory) – it needs to understand the current phenomena (data). The literature review found ample standalone descriptions, but very few describe the integrated hydrology, GIS, urban flood, and stakeholders concerning the ambitious frameworks. Such a situation is moderately favoured for the inductive approach.

Simultaneously, the well-developed stakeholder and hydrological theories and established understanding of the stakeholder and water management integration facilitates the hypothesis testing (theory), which is inheriting to deductive approach. Again, it creates moderate favouritism for the deductive approach. Nevertheless, if it selects the deductive approach, it needs to falsify or verify the hypothesis, which is impractical and impossible in flood research within a limited period. Therefore, the present study needs to select an intermediate approach, the *abduction,* as the wealth of information available with far less in the researching context and the ambitious framework will be a conscious explanation of existing epistemology in line with the current understanding (theories). Due to this specific scenario, abduction becomes the most suited theory-building approach to selected interpretivism philosophy. Figure A-4 illustrates relations of the reasons for the above decision.

As the present work follows the abduction approach with interpretivism philosophy, the work must explore a phenomenon using data collection. Then it needs to recognise the themes and (clearly) describe the patterns/trends, which requires producing the theory (new/modified) based on such situations. However, this new knowledge needs to be tested with additional data collection (Saunders, Lewis, and Thornhill, 2019, p.160).
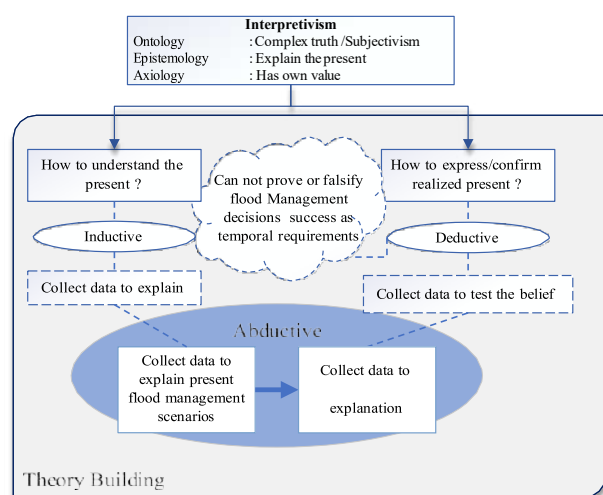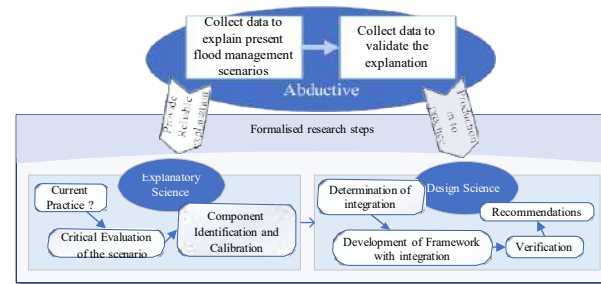

Figure A-4: Reasoning the theory building approach
Source: Author

This abductive approach collectively utilises the research principles of explanatory science and design science. According to Aken (2005), explanatory science's primary goal is to produce reliable knowledge to realise the natural

or social world for a more precise description/explanation/prediction. The fundamental purpose of design science is to produce information that specialists can utilise design solutions to their issues (Aken, 2005).

A1.2.3   Formalised research steps to theory building The general research steps could be formalised by keeping those concepts in mind, as shown in It was necessary to   follow   the explanatory science principle initially, which required more qualitative methods, as the little known phenomena (Stebbins, 2001, p. 6) of the integrated hydrology, GIS, urban flood, and stakeholders. Those steps are illustrated as downward rectangles of Figure A-8, where the intended objective is to demonstrate an actual social situation. When it describes more towards the present work, the research should explore the major urban flood management components in the current system setting. Such major components will demonstrate the present information system interactives required by the urban flood management systems.

However, as the demonstration assist the system specialists to solve the issues with stakeholders' perceptions, it must produce supportive knowledge to develop more realistic solutions as per the design science research principle. The next upward steps show (Figure A-8) the so-called design science steps to build the required knowledge to solve the intended problems. As such knowledge development is with design science, it must produce an artefact for specialists to utilise the design solutions to their issues. The intended artefact of the present work is a HydroGIS model development framework with current stakeholder integrations depths. Hence the expected outcome should clearly demonstrate the status quo stakeholder relations, and the depths between the sine-quo-none components have to be considered in system development. This output's epistemological understanding is that it will guide the system specialist to develop more legalistic solutions.

The initial development would be a fully or partially developed framework with depths resulting from the comprehensive study. These depths cannot be validated through implementation or operationalisation but only through expert reviews due to unrealistic time requirements. Since the so-called experts are in different disciplines, the depths and integrations may be differently interpreted and reviewed. Hence validating the framework would be a set of

improvement suggestions. The design science steps will be thus completed with recommendations developed based on the suggestions.

Accordingly, the formalised research steps are linked with the abductive theory building approach, as shown in Figure A-5.

Figure A-5: The relation between the Abductive method and Research Steps
Source: Author

A1.3 Research Methodology – Formulating the research Design

While the ontology and epistemology understanding provides the research foundation, the methodology explains how to find the solutions to research questions in line with the said foundation. "Methodology" is a theory that describes the overall plan of studying the research question/phenomena (Berryman, 2019), and "Research Design" is the descriptive plan of methodology. Research design shows how to answer questions, achieve the questions' objectives, the reasoning for data collections, and analysis.

A1.3.1 Methodological Choices - *Mixed Research Design*

From the available literature on the methodological choices, the present work started with Saunders, Lewis, and Thornhill (2019)'s suggestion to divide the methodological choices into three research designs, as shown in Table A-3.

Table A-3: Available Methodological Choices

Methodological Choices	Description	Continua
Quantitative Research Design	• Mostly with positivism, postpositivist, and deductive • Distinction needs between opinion/results and the respondents/sample's attribute • Examine the relationship between variables with statistical and graphical techniques • Utilises controls	Mono method: Single data collection technique Multi-method: Multiple data collection techniques
Qualitative Research Design	• Mostly with constructivism/interpretivism and inductive • Relationship between opinion and the participants (they are not respondents) • Non-standardised data collection needs classifications and analysis through conceptualisation	Mono method: same as above Multi-method: same as above
Mixed Research Design	• Mostly with pragmatism and critical realism • Maybe inductive, deductive, or abductive • Combine quantitative and quantitative methods, either concurrent/convergent, complementary, sequential /multiphase sequential	Convergent: same question answered by qualitatively and quantitatively Different questions are answered using both methods one after the other (sequentially) or same time (Complementary)

Sources (Berryman, 2019; Flick, 2018; Morgan & Hoffman, 2021; Saunders et al., 2019; Stebbins, 2001; Teddlie & Tashakkori, 2009; Wheeldon & Åhlberg, 2012)

A1.3.1.1 Theoretical Justification

The present work adds several other prominent authors' explanations to Saunders's classification. The *description* column of Table A-3 provides general descriptions available for research design types by different authors, while the *continua* column summarised the different methods practised. Even though the literature clearly demonstrates qualitative and quantitative designs, the mixed method explanations are still under development as most researchers in the present day are not following the pure qualitative or quantitative methodology. However, mixed-method is with the pluralistic perceptions; i.e., it tolerates the mixed-use of opposition research designs.

Present research works are primarily abductive research in interpretivism philosophy. According to Table A-3, the interpretivism philosophy should be mainly with the qualitative research design, while the abduction is with the mixed method. However, all research designs prioritise the favouritism of research philosophies, not rejections. Those also show the same attention to inductive, deductive, and abductive reasoning. However, when the researchers are on the mixed method, frequently the explanations describe the relation between abductive and mixed-method as sine-quo-none (Flick, 2018, p. 52; Wheeldon & Åhlberg, 2012, p. 116). Therefore, it is vital to assess the theoretical understanding with the present study scenario.

A1.3.1.2 Justification to a practical approach

Evaluating the present formalised research steps (Figure A-8) over the required undertake and analysis method showed that present research must sequentially employ both methods, as shown in Table A-4. The quantitative analysis of the present research (Serial no. 4 of Table A-4) required to collect data from literature qualitatively, *quantitised* the qualitative data with numerically coding, statistically

analyse the numerical coded data, and get the quantitative output. Further, it is required to *qualitised* quantitative outputs again when validating the framework for easy understanding by the experts in their terms. According to the logic demonstrated in the introduction (under the "Nature of research"), the study combines exploratory, descriptive, explanatory, and evaluative research natures. Therefore, the present research approach should be considered a *sequential multi-phase approach of mixed-method,* based on all these research facts and the theory explanation (Saunders, Lewis, and Thornhill, 2019, p.182). Figure A-6 demonstrates the justification for such selection.

Table A-4: Analysis methods of formalized research steps

| Formalised Research Steps	Undertake	Analysis
1. Understand current practice	Literature Review	Qualitative
2. Critical Evaluation of the scenario	In-depth analysis of selected HydroGIS tool, develop guidelines and procedures	Quantitative & Qualitative
3. Component Identification and Calibration	Axiological Use case analysis, Literature Survey, Expert Review	Qualitative
4. Determination of integration	In-depth Literature Survey	
5. Development of Framework with integration	Multi Attribute Utility Theory (MAUT) and Weighted Average Programming in Multi-Criteria Analysis (WP – MCA)	Quantitative
6. Validate Framework	Questionnaire	Quantitative & Qualitative
7. Recommendations	Axiological analysis	
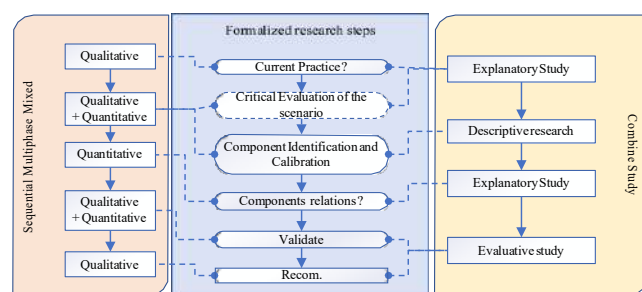
Source : Author

Figure A-6: Relation between mixed method and combine method with research steps
Source: Author

A1.3.2 Purpose of Research – *Combine method study* The research purpose is important in a research design as it clarifies the real research requirement. The present research employs multiple methods, i.e., an *explanatory study* to evaluate the present state-of-art for narrowing down the research to a specific gap, *descriptive research* to identify the themes, an *explanatory study* to explain the relations between themes, and an *evaluative study* to the applicability

of themes and those relations. Error! Reference source not found. demonstrates the justification for such selections. Therefore, the present research facilitates openly reasoning out the rest of the research plan.

A1.4   Chosen Research Strategies – Survey/Doc. Research/Grounded Theory
The research strategy explains the action plan to obtain answers to research questions. Those should be matched with the foresaid philosophy and methodology/design. However, the present research's philosophy, interpretivism, allows the researcher to develop the research design creatively. It developed a so-called *creative design,* as shown in Figure A-7, which illustrates the relationship to previous decisions.

Figure A-7: Selection of methods aligned with research strategies
Source: Adopted from several authors, indicate them in latter sections
Fundamentally, positivism considers that reality exists independently from humans, but interpretivism explores human reality construed by the social and its actors. The present research is an abductive approach of theory development more biased to interpretivism, but it philosophically agrees to pragmatism. It is identified that this will be mixed-method research and apply both the exploratory science and design science research principles. Therefore, when selecting research strategies, it must be a qualitative and a quantitative research design strategy, and thus, the present research must mix strategies appropriately. The following subsections reason out the suitability of selected strategies and elaborate how to use them in this research.

A1.4.1 Qualitative research strategy – *Grounded Theory*
A1.4.1.1 Theory explanation
The present research should analyse, interpret, and explain the socially constructed scenario. The said purpose can be achieved by following the Glaser and Strauss (1967) Grounded Theory (GT) methodology, as it discovers "Theory" from "data" collected from the social environment. Even Glaser and Strauss separated later and developed the theory in two directions that fundamentally remains unchanged.
Glaser highlights that the core of the approach needs to be induction; hence he stopped the literature review until data coding, a middle milestone of the process. However, Strauss's branch of GT, which is induction-focused but allow a systematic approach that emphasises validation, is more in line with the current research requirement (Deterding & Waters, 2021).
This approach is named "constructivist grounded theory"- CGT (Bryant, 2002; Charmaz, 2006, 2016). It incorporates researchers' and participants' interpretations to construct the concepts. There, the individual's positions, roles, backgrounds, and values are recognised. However, the

present research refused the GT derives from positivism as the philosophical selection. Still, the CGT grows into interpretive tradition with more pragmatism continua (Charmaz, 2006), where the present research lies. However, in addition to CGT, the other branches of GT such as Critical Grounded Theory (assists research with a realist perspective - one reality explains how people's interprets are shaped/moderate it) and Situational Analysis (crating situational maps of major elements, their context, and positionalities) also somewhat agree with present work. Therefore, the present work selected the common continua of GT, where the core principles are included. Those core principles are (1) "Grounded" thinking – welcome unanticipated findings, (2) Multiple data capturing to explain the context, (3) Pursuing theory through data – a must close-reading of data, and (4) Theoretical sampling – as conceptual classifications are required. Further, the present work has considered a few myths to exclude, such as (1) The research should produce full-pledged theory, (2) Should not gather literature knowledge/theory at the beginning – Glaser's Argument, and (3) The time taken to coding is extensive (Timonen, Foley, and Conlon, 2018).

A1.4.1.2 GT Suitability

The unexpressed primary data collection for the method is done through interviews and discussions. Those speeches were transcribed, codes constructed, and analysed repetitively until reaching theoretical saturation. The design science approach/development and validation of framework with recommendations (Figure A-8 and Table A-4) could not be incorporated if crudely implemented such methodology for this research. However, GT could be employed in framework construction in the explanatory design steps of component identification and calibration. In line with Strauss's branch of GT, the present research can construct the codes through an axiological use case and literature survey and calibrate through discussion. Table A-5 presents the planned map of the present work and GT steps.

Table A-5: Map of Research Steps and GT steps

Extracted Research Steps from Error! Reference source not found.	Undertake	Undertake - Repetitive steps of GT mapping	Repetitive steps of GT (Sharma, Sengupta, and Panja, 2020)
3. Component Identification and Calibration	i. Axiological Use case analysis ii. Literature Survey iii. Expert Review	i – a to c ii and iii – a to d	a. Theoretical data sampling b. Conceptual labelling c. Memo creation d. Coding (conceptualisation)

Source: (Sharma, Sengupta, and Panja, 2020)

A1.4.2 Qualitative research strategy – *Documentary Research*

The modified GT can be applied to get the core outcome expected from the descriptive research to identify the themes. However, it required an explanatory study to evaluate the present state-of-art for narrowing the research to a specific gap, hence the need to assess the existing documents developed on the current knowledge areas. As this task is already completed and explained in Chapter 2, this chapter provides no further details.

A1.4.3 Quantitative research strategy – Survey

The remaining research consists of two studies: (1) the explanatory study to explain the relations between themes and (2) an evaluative study to evaluate. In this requirement, the survey strategy provides a well-established practice. It fundamentally agrees with the deductive approach for collecting thoughts and behaviour of a population over the known phenomena (Saunders, Lewis, and Thornhill, 2019, pp.193–194).

It can employ the data collection and analysis techniques aligned with the survey study to the latter part of the present research - design science approach (development and validation of Framework with recommendation shown in Figure A-8 and Table A-4). The survey strategies indicate that it could identify how the component of the present situation is interacting/integrating and evaluating the experts' review to develop a conclusion.

A1.5 Time horizon – Cross-Sectional Study

The present research must understand the existing phenomena rather than how they were developed to the present situation from the historical phenomena. The present research has to be a cross-sectional study. However, as the present research is interested in the temporal based flood, it influences longitudinal studies. Nevertheless, a myriad of research has implemented cross-sectional studies to investigate flood decision making, perceptions, preferences, behaviour, and people responses (Hudson, Thieken, and Bubeck, 2020). Hence, a cross-sectional study is selected for the present research.

Although the research study follows the cross-sectional method, it is interested in considering what period covers the term "cross-sectional" for the present disciplines. It can observe that the perspectives on flood management decision-making have been changing very slowly since it appeared as science. For example, IWRM, a popular theme today; was originated in the 1970s and have been discussed extensively over the years; but it took an average of 40 years to implement practically. As well, hydrology is also a mature science. Undoubtedly, the cross-sectional signifies 30 to 40 years for the present research.

3. Conclusion

As the present work's main objective is to develop HydroGIS model development framework for software professionals, it justified to develop a building block software framework and verify using expert review as described in the of Appendix 2.0. According to the Error! Reference source not f ound. (p. Error! Bookmark not defined.) description, flood management related

research must plan preciously and creatively as the difficulty in verification. This scenario directed the present research to not to simply follow a ready-made research methodology, but to carryout in-depth study to make the research decisions systematically. Then a comprehensive study was carried out to clear the ontological, epistemological, and axiological axioms and could be able to develop a verified mind-map to illustrate the relations between frequently using terminologies in research. All the related activities are described in section 0 (p. 2) of Appendix 2.0.

Even though the axiological stance of the researcher built the creative research methodology for the research, there are common acceptances on the better research methods according to the discipline. Accordingly, this research is about the conceptual relation between water management and scientific modelling to develop HydroGIS models. Then this study has more managerial perspectives, which most water management and systems development researches have. Therefore, the present research selections were reviewed under the management and information system management perspectives. The current study developed a path map of research design according to the developed mind- map, which answers research questions through identifying the objectives, collecting the intended data, and analysing them with the fundamental understanding of constraints (Error! Reference source not found.). The selected research options for the steps of the path are reasoned out and linked as shown in Table Error! No text of specified style in document.-1.

Table Error! No text of specified style in document.-1
The reasons for selecting conceptual philosophies for the research

Concept	Selected	Reason
Philosophical axiom	Epistemological axiology	The socially accepted knowledge is generalised, including the author's belief. The author's extensive experience
Dimension of continua	Social Constructivist - Subjectivism	

Philosophy	Interpretivism	The research inducts the theory as an explanation of the present social status
Approach	Abduction	The knowledge is constructed qualitatively, but the framework is constructed qualitatively; Then framework evaluation conducts qualitatively and quantitively
Research method and Methodological choice	The sequential multi-phase approach of the mixed method	
Strategies	Constructivist grounded theory	The exploratory phase of the research is based on the situational analysis
	Documentary Research	State-of-art of the subjected areas based on the availed material
	Survey	Construction of framework (the present status) needs to gather data qualitatively and analyse quantitively
Time Horizon	Cross-sectional	The study analysis the present status

Source: Author

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NT Sohan Wijesekera is a senior professor (Civil engineering) in University of Moratuwa. He is an elegant hydrologist who won the Presidential CVCD Award for his research contribution. Snr Prof Sohan has been served more than forty-one years in the national water resource management industry and teaching in the university. He supervised more than 60 post graduate researches including PhDs. Presently he serves as the Chairman of the Board of Directors, Construction Industry Development Authority, Sri Lanka.

Table A-6: HARP Test of the present research

	Your views on the nature of reality (ontology)	Strongly Agree	Agree	Slightly Agree	Slightly Disagree	Disagree	Strongly Disagree	Score
1	Organisations are real, just like physical objects.			x				1
2	Events in organisations are caused by deeper, underlying mechanisms.		x					2
3	The social world we inhabit is a world of multiple meanings, interpretations and realities.			x				1
4	'Organisation' is not a solid and static thing but a flux of collective processes and practices.		x					2
5	'Real' aspects of organisations are those that impact on organisational practices.		x					2
6	Organisational research should provide scientific, objective, accurate and valid explanations of how the organisational world really works.		x					2
7	Theories and concepts never offer completely certain knowledge, but researchers can use rational thought to decide which theories and concepts are better than others.		x					2
8	Concepts and theories are too simplistic to capture the full richness of the world.			x				1
9	What generally counts as 'real', 'true' and 'valid' is determined by politically dominant points of view.			x				1
10	Acceptable knowledge is that which enables things to be done successfully.				x			-1
Your views on the role of values in research (axiology)								
11	Researchers' values and beliefs must be excluded from the research.				x			-1
12	Researchers must try to be as objective and realistic as they can.			x				1
13	Researchers' values and beliefs are key to their interpretations of the social world.		x					2
14	Researchers should openly and critically discuss their own values and beliefs.			x				1
15	Research shapes and is shaped by what the researcher believes and doubts.					x		-2
Your views on the purpose of research								
16	The purpose of research is to discover facts and regularities, and predict future events.				x			-1
17	The purpose of organisational research is to offer an explanation of how and why organisations and societies are structured.			x				1
18	The purpose of research is to create new understandings that allow people to see the world in new ways.		x					2

No.	Statement						Score
19	The purpose of research is to examine and question the power relations that sustain conventional thinking and practices.					x	-2
20	The purpose of research is to solve problems and improve future practice.	x					2
Your views on what constitutes meaningful data							
21	Things that cannot be measured have no meaning for the purposes of research.				x		-1
22	Organisational theories and findings should be evaluated in terms of their explanatory power of the causes of organisational behaviour.					x	-2
23	To be meaningful, research must include participants' own interpretations of their experiences, as well as researchers' interpretations.	x					2
24	Absences and silences in the world around us are at least as important as what is prominent and obvious.		x				1
25	Meaning emerges out of our practical, experimental and critical engagement with the world.	x					2
Your views on the nature of structure and agency							
26	Human behaviour is determined by natural forces.					x	-2
27	People's choices and actions are always limited by the social norms, rules and traditions in which they are located.		x				1
28	Individuals' meaning-making is always specific to their experiences, culture and history.	x					2
29	Structure, order and form are human constructions.		x				1
30	People can use routines and customs creatively to instigate innovation and change.	x					2

Research Philosophy	Score	Reflection:
Positivism (Questions 1,6,11,16,21,26)	-2	*1.* Have I got an outright philosophical winner? – *Yes Interpretivism*
Critical Realism (Questions 2,7,12,17,22,27)	5	*2.* Why do I think this is? – *My epistemological position is most suited to that of relativism and realism*
Interpretivism (Questions 3,8,13,18,23,28)	10	
Postmodernism (Questions 4,9,14.19,24,29)	4	*3.* Which philosophy do I disagree with most? – *Positivism*
Pragmatism (Questions 5,10,15,20,25,30)	5	*4.* Why do I think this is? – *Not a suitable research philosophy for exploratory research*
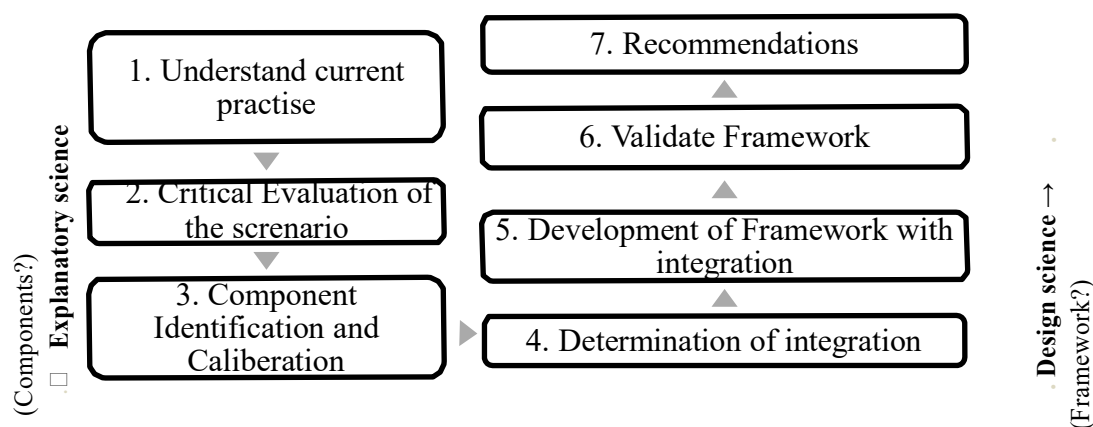
Figure A-8: Formalized Research Steps
Source: Author

1. Understand current practise
2. Critical Evaluation of the scenario
3. Component Identification and Caliberation
4. Determination of integration
5. Development of Framework with integration
6. Validate Framework
7. Recommendations

Explanatory science (Components?)

Design science → (Framework?)

A Self-Monitoring System for Online Education

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Abstract: *Over the past decade the rapid growth of technology has resulted in online learning gaining a lot of traction as the preferred method of studying amongst students. Accelerated further by the COVID-19 global pandemic, online education has overtaken traditional classroom education as students' preferred choice in learning. Traditional Classroom teaching has always been bi-directional, involving interactions between students and their teachers. Online Education in comparison has become more uni-directional and this lack of interaction between the student and teacher can severely impede a student's concentration. In addition, the presence of countless other distractions in a virtual environment has contributed towards students being more demotivated and uninterested in their education. This has brought the true effectiveness of online education into question. It is with the intention of countering these problems that a Self-Monitoring System for online education has been developed. The System will be developed to follow the guidelines of the Buddhist Philosophy of "Iddhipada" and will monitor students in a variety of ways including tracking emotion and monitoring activity which would help to improve concentration, motivation and produce better results. It is hoped that this system will help make online education as productive and focused as it can be.*

Keywords: *Self Monitoring System, Emotion Recognition, Artificial Intelligence*

1. Intorduction

The COVID-19 global pandemic has resulted in traditional classroom learning being shifted to online learning at all levels. Much more than just a new twist on distance learning, online schooling is changing the face of traditional classrooms and making education more accessible than ever before. By 2026, the global e-learning industry is projected to reach $336.98 billion. Digital Learning is also the quickest growing market in the education industry, with a whopping 900% growth in the past 20 years. 10 of the largest educational institutions in the world enroll as much as 20% of all online students. [1]

As evidenced by the statistics, online education has helped widen the horizons and the reach of education; however, it has not been without a host of challenges and obstacles when compared to traditional learning. Despite its powerful growth online education lowered a student's final grade by about 0.2 standard deviations. This may be indicative of certain issues present in the sphere of e-learning.

Traditional Classroom teaching has always been bi-directional, involving interactions between students and their teachers. This form of teaching was the mainstream avenue of education that existed for centuries prior to the Covid-19 pandemic. A traditional classroom is one where a teacher moderates and regulates the flow of information and knowledge. Students are expected to continue developing their knowledge of a subject outside of school through homework exercises. Here, students' main resource is their instructor who only teaches them face-to-face.

Online Education in comparison has become more uni-directional. Very often, online learning simply involves teachers lecturing through an online platform such as Zoom or Microsoft Teams to students that they, in most instances, cannot even see or hear. Most students in online classrooms have their microphones muted and video cameras switched off. There is no interaction between the student and teacher.

Students may be uninterested and de-motivated in their education. They may abandon listening to the lecture, they may not take notes and they may not interact with the teacher via questions or discussion sessions. . Coupled with the free use of laptops and mobile phones during classes, distractions have become countless, often coming at the cost of focusing during class. In fact, the student may even have logged into the lecture and simply abandoned their device to engaged in other tasks.

Teachers themselves often complain of a lack of tools to make the classes engaging, leading to a loss of interest from both parties. With the lack of any accountability in the online teaching method, education quality often becomes compromised. The physical presence inside a classroom with a teacher and fellow peers often leads to an atmosphere that can't be replicated through virtual means.

To sum up the above, the lack of personalized interaction between students and teachers in an online learning environment causes students to struggle with concentration and motivation in their studies. This impedes their ability to learn and develop at an adequate pace. Teachers themselves cannot monitor if a student is actively listening to the lesson and absorbing information.

It is with the intention of countering these problems that a Self-Monitoring System for online education has been developed. The System will be developed to follow the guidelines of the Buddhist Philosophy of "Iddhipada" and will monitor students and provide helpful suggestions for them to have increased levels of interest and dedication towards their studies and maintain high levels of concentration and motivation.

This article does a deep dive into the developed Self-Monitoring System for online education . It has been divided into several sections that will touch in order, the problem addressed by the system, the proposed solution, the existing systems related to online education along with their pros and cons, the design of the Self-Monitoring System, technology used and details on the system in action. The article will wrap up with its conclusions and references.

2. Review of Existing Systems

There are many existing systems, tools and technology that are used for Online Education. The developed Self-Monitoring System makes use of technology such as emotion recognition and chatbots combined with a learning interface that houses all the material to be used by students. Therefore, this subsection will mainly touch on existing learning management platforms, existing virtual meeting platforms and existing AI tools such as emotion recognition and chatbots.

A. Learning Management System (LMS)

A Learning Management System (LMS) is a robust platform that holds course content, materials and administration in one user-friendly online system. The phrase itself can be broken down based on its three words. Learning is the core of delivering any educational or training program by an individual. Management is the stem of the learning program which manages all the schedules for each and every individual. The system is nothing but an e-platform to deliver the learning programs. LMS is designed to help an individual to develop, manage and provide online courses and programs to learn. It provides a platform for the students and instructors to learn and highlight their skills wherever and whenever they want as per their convenience.

There are a multitude of LMS platform currently available in the market. The table below explores the features and limitations of existing LMS systems.

Table I. Summary of LMS Platfroms Reviewed

Learning management platform	Features	Limitations
Mindflash	Facilitate creating training courses within minutes Robust learning experience for users Easy-to-use interface Scalable	No ready-made templated Limited Styles for Quizzes Adding voice-over can be difficult
SkyPrep	Standardized courses Customizable reports Strong security features	Limited user role customization No downloads for mobile users No gamification Built in authoring tools are too simple
iSpring Learn	Online Tests Self-Assessments Portable	Knowledge articles cannot be filtered out Overwhelming for new features
Talent LMS	Fully Customizable Easy to Use Streamlined Mobility and flexibility in courses	Lack of system notifications Unavailability to integrate a grade book to the system.
Docebo	Secure Uses AI powered technology Content curation and aggregation	Live training and recording features are limited No way to indicate completed course
Moodle	Open Source Easily Customizable Widely Available Familiar	Not fully developed to cope with big projects The more students that access the platform, the slower the system becomes
SAP Litmos	Collaboration facilities Tracking	Website can also shut down on occasion Customization cannot be done without coding knowledge
Canvas	Dynamic Effective Course Design Zoom Integration	Low speed of grading Issues in integration features

B. Exsiting Virtual Meeting Platforms

Virtual meeting platforms are video applications and software that bring people together over the internet. Usually, this software includes a form of video conferencing, as well as tools like chat, reactions and screen sharing. Virtual meeting platforms are being used as the primary platform to conduct online education and lectures at both school and university level.

Table 2. Summary of Virtual Meeting Platforms

Virtual Meeting Platform	Features	Limitations
Livestorm	Easy-to-use interface Automated Recordings In-room features such as emoji reactions, video sharing, team whiteboards, live polls and questions upvotes	Many features available only for group meetings, not 1:1
Google Meet	Noise cancellation, Up to 250 attendees Meeting videos saved to goggle drive Strong security features	Difficulty in integrating with third party applications Limitations in some features such as the whiteboard.
Microsoft Teams	Easy to schedule meetings through the Outlook calendar Record meetings Virtual backgrounds Shared whiteboards, Breakout Rooms	Not user friendly for some users Primarily a messaging platform
Zoom	Polls, Whiteboards Breakout room Virtual backgrounds, Snapchat-style filters Reports	Limited Storage Capacity Have to download to use
WebEx	Screen sharing Breakout rooms Virtual backgrounds Live polling Real gesture emoji features	Additionally have to download Cisco Webex Productivity Tools Some features are limited in-browser

While these platforms come with inherent features that may contribute to improving the learning experience, it still does not ensure that the student is being monitored and learning at the required pace. As mentioned, before it would be quite easy for the student to simply log onto the meeting from their device, mute their microphone, switch off their cameras and simply have their focus be elsewhere. That said, virtual meeting platform are still one of the major components in online education. Some of the most popular and their respective advantage and disadvantages have been covered in more detail below.

C. Exsiting Emotion Recognition Techniques and Tools

Emotion Recognition involves the analysis of various facial features to match them to their common corresponding facial expressions. For example, an emotional state of anger is characterized by burrowed eyebrows, intense gaze and raised chin. An emotional state of joy would however be shown by characteristics such as raised corners of mouth into a smile

Most emotion recognition systems tend to follow a sequential flow in carrying out the process of emotion recognition. First, the relevant input such as the facial image will be fed into the system. Then different types of techniques and tools will be used to analyze and extract the important features of these inputs. Afterwards, these features will be matched to the most appropriate emotion corresponding to them. "Fig 1" depicts the flow diagram that applies to general process of emotion recognition systems.

Input Image Aquistion

Pre-processing and Segmentation

Feature Extraction

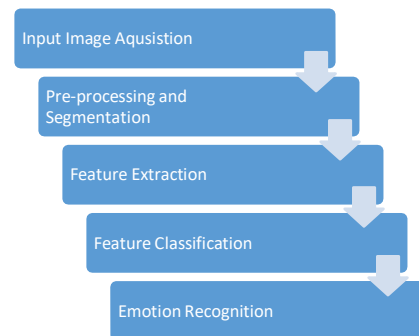Feature Classification

Emotion Recognition

Fig 1. Flow Diagram of an Emption Recognition

Many systems have been developed over the years for the purpose of emotion recognition. This section highlights the main features of some of those systems.

Table 3. Summary of Techniques and Tools Reviewed

System Name	Techniques and Tools Used
Emotion Based Msuic Recommendation System	Image pyramid Histogram of Oriented Gradients Linear Classifier
An Intelligent System for Facial Emotion Reciognition	Facial Animation Parameters Dynamic Committee Machine (DCM) Feed-forward back propagation neural network Luminance and Edge based masks
A Combined Approach for Emotion Recognition using Bezier Curve and Facial Expression Analysis An Intelligent System for Facial Emotion Recognition	Bezier Curve WEKA machine learning calculations ANN
Facial Emotion Detection to Assess Learner's State of Mind in an Online Learning System	Convolutional Neural Networks
Deep Learning for Robust Feature Generation in Audiovisual Emotion Recognition	Forward Selection Information Gain Principle Component Analysis Gaussian Restricted Boltzmann Machines Deep Belief Networks (DBN)
Modeling of Recommendation System Based on Emotional Information and Collaborative Filtering.	Algebraic energy End-Point Detection Feature Parameter Extraction Gaussian mixture model Hidden Markov model Support vector machine Artificial neural network
Emotional Recognition from Facial Expression Analysis using Bezier Curve Fitting	Bezier Curve Spatial filtering
Fast Facial emotion recognition Using Convolutional Neural Networks and Gabor Filters	Gabor Filters Convolutional Neural Networks

As observed from the systems above, emotion recognition is one of the many facial recognition technologies that have developed and grown through the years. The systems developed thus far for emotional recognition have covered several different techniques and tools. However, they have also come with certain drawbacks and areas for improvement.

For instance, there are several different ways that a system for emotional recognition can be designed. Choosing what model or training data to use is not the end of it, as there are different inputs that can be used or given to the system to analyze. For example, video, speech, text, conversation are all possible inputs that can be used for emotion recognition. While most systems discussed above focus on Images as the

input to the system, Kim Y et al [8] also takes in account audio cues and designs a system high in accuracy. Thus, the systems that focus on just a one specific input may benefit from also branching out to other audio or sensory inputs. This may however result in high costs and complex systems, a factor which must be taken into consideration.

D. Chatbots

A chatbot system uses conversational artificial intelligence (AI) technology to simulate a discussion (or a chat) with a user in natural language via messaging applications, websites, mobile apps or the telephone. It uses rule-based language applications to perform live chat functions in response to real-time user interactions.

Two preliminary applications for Chatbots within education have been identified through a study carried out by S Cunningham-Nelson et al [40]. The two applications are as an FAQ Chabot to answer commonly asked questions, and a short response quiz Chatbot. These applications are discussed below.

i. FAQ Chatbot

The aim of this type of FAQ chatbot would be to anticipate and reply to some of the common queries that are made by students. If a student writes a question to the Chatbot, the question can be matched with a question in the existing database that is most similar, and then the response that is most relevant is chosen and given to the student. An FAQ chatbot has the clear benefit of being available for students 24/7, able to answer their questions when needed in time. This style of FAQ Chatbot has the potential to help identify communication issues between educators and educators and students. If one of the questions is asked more frequently by students, educators may need to consider how that is currently communicated to students.

ii. Short Response Quiz Chatbot

Another application which we believe a chatbot could have a significant impact in, is in the context of online short response questions. For example, students may be asked to respond to a multiple-choice question, giving a justification about the answer they had selected. The chatbot would facilitate this interaction and then provide some personalized feedback. The benefits of this chatbot mirror the general benefits for Chatbots, including a more personalized approach for users and the 24/7 availability of the Chatbot. Implementing this style of textually enhanced concept inventory as a chatbot would allow for other benefits, specific to this application.

3. Design of The Self Monitoring System for Online Education

As reviewed above there are many different systems, platforms and techniques available to aid in education. A few notable gaps in literature would be the absence of a proper philosophy setting the foundation for a learning

management system. In addition, simply the presence of study material does not indicate that the student would be listening or learning at the rate required. An emotion recognition plug in would greatly increase the learning rate of students an ensure they are actually paying attention.

Taking into account the above gaps in literature, the following system has been developed. A Java based desktop application to self-motivate students in their education, based on the Buddhist Philosophy of Iddhipada, through the use of techniques such as emotion recognition, multi-agent systems, chatbots and interactive GUIs.

The functional requirements of the system are as below:

- Create a Learning Environment for a student based on the Buddhist Philosophy of "Iddhipada"
- Provide learning Materials and Questions relating to the subject area.
- Monitor the student and track their emotional state, concentration and motivation levels.
- Provide support and suggestions to the student from the backend of the system, to improve their emotions, concentration and motivation levels
- Have a Chatbot with which the students can interact

i. *Philosophy behind the project*

The Self-Monitoring System is based on a Buddhist Philosophy by the name of "Iddhipada" which highlights four bases of spirituality that can be followed when undertaking a task. If all four of these bases are followed in equal and adequate amounts any undertaken educational task will be successful.

The 4 bases touched on are :
- 'Chanda' - Intention and Interest
- 'Citta' – Positive Mindset
- 'Viriya' - Effort and perseverance
- 'Vimansa' - Curiosity and an investigative nature

ii. *Methodology and Design Diagrams*

The methodology used for the design of this system was the scientific method which has its steps in the following order: Observation of the research problem, Preliminary Study, Problem Definition, Build up theoretical, Hypothesis, Experimental Design, Data Gathering, Data Analysis, Conclusion.

The top-level design of the developed Self-Monitoring System can be depicted as in "Fig: 2."
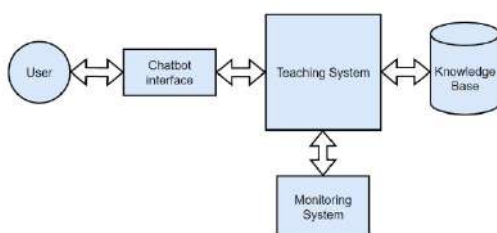
Fig 2. Top Level Design

It consists of the user interacting with the teaching system via a chatbot interface. The database connected to the teaching system houses all necessary material for the system. The monitoring system will interact with the teaching system as required. "Fig: 3" touches on the design of the monitoring system in more detail.
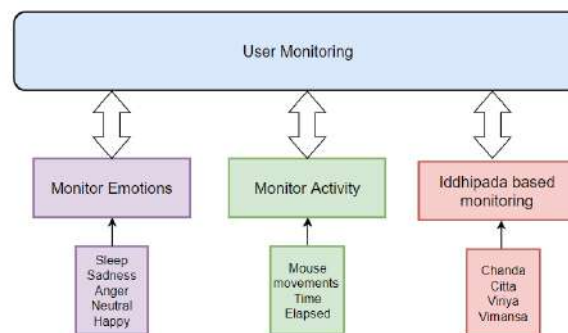
Fig 3. Monitoring System

There will be three types of monitoring carried out by the system. One of the monitoring aspects will monitor emotions and provide helpful suggestions on how a negative emotional state can be changed to a more positive state. Secondly activity of the student such as mouse movements and timing will also be monitored to ensure that they are focusing on learning. Thirdly, values for the four Iddhipada bases will also be maintained and monitored. Each of the questions in the system will be assigned specific Iddhipada weightage and according to the questions answered by the student, their overall value will change .

When focusing specifically on the tools and technology used for the system, it can be said that Java was used as the coding base. All interface design and most features of the system of the PHP + MySQL was used for the database. The emotion recognition portion is carried out by using TensorFlow and Keras. The chatbot was implemented through a compatible framework.

4. Implementation Of The Self Monitoring System For Online Education

The implementation of the Self-Monitoring System for Online Education can be described in terms of its various modules and functions.

i. *Account Creation and Login*

The student may log into the system by first creating an account. The student's information including username and password will then be saved to the database. Students may

Fig 4. User Login and Create Account

use this username and password to login to the learning system.

ii. *Selection Of Subject And Chapter And Accessing Material*

After the student has logged in, they can select the necessary subject and then chapter and gain access to the material. The learning material will be available in the form of video and pdf lessons. In addition, there will quizzes available to test the knowledge of the student. "Fig: 5" shows the interface for selecting the subject as mentioned above.

Fig 5. Select Subject

iii. *Capture Of User Image And Recognition Of Emotion*

The image of the student will be captured periodically while they are engaged in studies. This image will be fed to the emotion recognition model which will identify the current emotional state of the user and provide solutions on how to improve this state if necessary.

iv. *Attempt Quizzes*

The student may attempt quizzes in order to test their knowledge. There are three different types of quiz questions: short answer, MCQ and images. Each of these questions is geared towards understanding where a student stands and what areas they must improve on. Each answer given by the student will be checked against the database of answers, it will be marked as either correct and incorrect and feedback will be provided. "Fig: 6" shows the interface for quizzes.
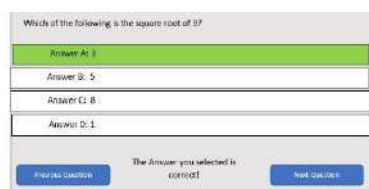
Fig 6. Quiz Interface

v. *Record other monitoring details of student*

The system will also monitor other aspects of the student such as time elapsed in answering questions and the mouse movements during studying. These stats can be used to know if the student is focusing as necessary on their work.

vi. *Interact with Chatbot*

The student will be able to interact with a basic level chatbot. This chatbot will respond to simple queries made by the student and provide basic guidance. It is hoped that

the presence of a chatbot will further aid in improving the student's level of concentration.

That concludes a description of the major features of the Self-Monitoring System for Online Education. The above developed system could go a long way towards furthering online learning and ensuring learning happens at the most productive rate possible.

5. Conclusion

The Covid-19 Pandemic has seen the shift in traditional forms of learning to online learning at all levels. However, Online Education is not without its own unique set of challenges. The lack of personalized interaction between students and teachers in an online learning environment causes students to struggle with concentration and motivation in their studies. This impedes their ability to learn and develop at an adequate pace. Teachers themselves cannot monitor if a student is actively listening to the lesson and absorbing information. The physical presence inside a classroom with a teacher and fellow peers often leads to an atmosphere that can't be replicated through virtual means.

There are already several systems in existence to tackle these issues. These systems range from learning management systems, virtual meeting platforms, emotion recognition tools and chatbots. However, the existing systems all have their specific disadvantages and a clear gap in literature can be identified.

It is as a solution to this gap in literature that a Self-Monitoring System for Online Education was developed. The system is a Java based desktop application developed with the goal to self-motivate students in their education, through the use of techniques such as emotion recognition, multi-agent systems, chatbots and interactive GUIs. The design of the system as well as a demonstration of what the system would be like in action, was provided.

The system will be tested by means of a control experiment involving a classroom of students. They will be taught two similar sample lessons online, one whilst using the system and the other without. The students can be given a quiz to complete after both lessons. If there is a significant improvement in answers in the instance that the self-monitoring system is used, that proves the effectiveness of the system in online education.

In conclusion, it can be said as the popularity and demand for a fully digitalized world grows, it is necessary to start developing new systems to keep up with the upward moving trends. It is hoped that the developed Self-Monitoring System for Online Education will contribute towards bridging the gap between offline and online education and will create a excellent learning environment.

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Sibil AI: Children Story Generator in Sinhala using Transformers

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Abstract: *Ever since the birth of humankind, stories have been used as a means of sharing information and educating people. Stories are more than just a form of entertainment; they impart lessons that often help children to develop the skills they need to thrive in life. Research and development teams have unquestionably mastered the practicalities of producing human-like creative text tales, which has been a significant barrier in natural language processing in recent years. A system based on artificial intelligence that generates children's stories can serve as a resource for parents and children to connect with. The ability to generate natural language stories that people can understand, remember, and enjoy is difficult to achieve with current technology. A new model based on transformers is introduced in this paper. This new approach for generating stories for children based on the GPT-2 model with the help of a web application. The GPT-2 is a model based on neural network that is designed to imitate the human behaviour of producing creative and coherent text. It can generate stories in different genres and starting captions. The web application takes advantage of the GPT-2 model's ability to generate fluent texts, including proper punctuations, complex syntaxes, and grammar rules. The solution allows users to generate creative stories from different genres with starting captions. Especially, using the proof-of-concept to support the narration given in Sinhala language, one of the native languages in Sri Lanka.*

Keywords: *Artificial Intelligence, GPT-2, Story Generator*

1. Introduction

Communication done through a behaviour called storytelling is a way of communicating through many different forms of art, like poetry or music. The study found that storytelling using the native language of the children brought an emotional upbeat utilizing analogies to communicate stories using metaphors. It has been proven and seen through every single person's life that the roots of a person how well they turn out to be in their adult lives go a long way back to their childhood. These root causes can be interactions of a range of biological, psychological, and social variables which can act as the accelerating and maintenance factors. Storytelling can be an effective means to provoke positive emotions in people. This is especially obvious in children who are above the age of five. By seeing outcomes, they will also see how they make them happen. This also helps children to understand that they are capable of achieving something when they set a goal

and work hard enough towards it. The dataset we use for training and testing have a significant impact on how well the generation of the narrative model performs. DL (Deep Learning) architects and designers consequently, using these self-learning mechanisms, transformer models and DL techniques employed several models. This paper aims to generate a transformers-based model that can produce stories with an amount of descriptive data that they have not been able to achieve in any previous literature.

This paper is formed with six sections which the research contributed in-depth.

Section I: Introduction sets the tone for the research through a brief overview of the problem, current solution, and the proposed solution with its major promising novel features.

Section II: Literature review is a collection of studies on the research findings that have been carried over creation of stories using a machine. Because the focus of this study is on GPT-2 transformer model and NLP problems in narrative production, the methods as well as the strategies that contributes to overall coherency and comprehension in the producing context, were critically examined.

Section III: Methodology sets forth the configuration of the technology utilized in the study with the innovative techniques used to build the narrative generator.

Section IV: Design and Implementation illustrate the proposed system's architecture and the action taken to implement the intended unique methods to developing the web application.

Section V: Results describes the proposed solution outputs after being implemented. The plan of evaluation and the actions were detailed in here.

Section VI: Conclusion concludes the study with the comments on the study endeavour. It specifies how the system's objectives were met, as well as its limitations. Furthermore, it makes recommendations for further research in this area.

2. Literature Review

Case-based reasoning model, data-driven approach model, suspenseful story generator, location-based text generators, and the go transformer models were built upon in the field of text generation in the early days.

Natural Language Processing evolved from intelligent question answering, dialogues, machine translation, and other systems into template-driven Natural Language Generation (NLG), that fits into pre-existing templates. Then it progressed to advance NLG, which divides facts from data to comprehend the most significant and fascinating one, which is referred to as deep learning. Simultaneously, the related technology has achieved several advancements including Recurrent Neural Network (RNN), Long

Short-Term Memory (LSTM), and the Sequence to Sequence(S2S) model through the emergence of the GPT-2 and Transformer-based BERT language model.

As this case study continues, (Hoppe and Toussaint, 2020) had shown that language models learn these tasks of question answering, machine translation, reading comprehension, and summarization; without explicit supervision when trained on WebText, a new dataset made up of millions of web pages. Typically, these tasks are approached with supervised learning on task-specific learning on the corresponding datasets. The GPT-2 model used here with a 1.5B parameter transformer delivers cutting-edge performance on 7 out of 8 evaluated language modelling datasets, although it still unfits WebText. These findings point to a viable direction for developing language processing algorithms that learn from examples that occur in real life.

Automated storytelling aims to construct a cohesive tale using intermediary documents were briefly researched (Rigsby and Barbara, 2017). By offering quantitative techniques of narrative quality evaluation that have been proved to have good agreement with human judgment, this study advanced the state-of-art. There were two developed automatic narrative evaluation techniques as dispersion, a metric for narrative flow, and coherence, a metric for the effectiveness of the middle-of-the-story articles conveys information about the connectivity between the start and the end. Chapters from Anne of Green Gables, Black Beauty, Peter Pan, and Treasure Island were divided into a single dataset and later combined with the Atlantic Storm dataset.

The encoder and decoder-equipped conventional networks or complicated Recurrent Neural Networks (RNN) serve as the foundation for the Sequence transformer models. To create poetry in Chinese, the sequence2sequence model combine the attention mechanism is applied in (Lin, Gao, and Chang, 2019). It is challenging to utilize in this context since the Chinese tale generation follows certain norms. In this case, the "Demi-Gods and Semi-Devils" dataset and a sizable dataset of Chinese short text summarization will be combined by FastText as input data.

As a novel solution, two Thai sentence creation machine was studied (Krukaset, Krukaset and Khancome, 2018). These computers use fixed patterns from the sentences that were manually evaluated. All fixed patterns are implemented within the machines using directed graphs. Tables are used to construct and display every path in a graph.

The Folktale Generator System (FGS) which served as the story grammar, is based on Vladimir Propp's theory (Zhang, Tran and Fangbemi, 2016) of narrative function. FGS enables users to intuitively create a variety of story plots by naturally sketching curves. Each useful Propp's theory segment is altered into ten versions, one of which is the original given a score attribute from one to 10 and then stored as text scripts in a database. By utilizing the numerous story possibilities, it provides, FGS may give old folktales a fresh perspective and strengthen the preservation of their cultural values. By utilizing the numerous story possibilities, it provided, FGS may give old folktales a fresh perspective and strengthen the preservation of their cultural value.

A revolutionary method for a control-and-edit transformer methodology that supports deleting policy and adding policy by using controlled imitation learning of editing distance from dynamic programming was studied by (Chen *et al.*, 2021). In the study, a weighting-reward with corpus stat possession which measures continuous rewarding for the controlled goal was described in the context.

An important area of NLP is the creation of sentences from provide starting words or the completion of incomplete phrases. It shows, in one way, whether a computer is capable of human thought and creativity. The study done by (Qu *et al.*, 2020) discuss programming the machine to perform a specific task before using it in NLP to aid with application in situations like summary creation, machine translation, and automatic question answering. For text generation and prediction, the OpenAI GPT-2 and BERT models were utilized extensively.

An interactive personalized story generation was discussed in (Yu and Riedl, 2012). A system demonstrated on a simple interactive story generation based on choose-your-own-adventure stories to evaluate the algorithms. In this study, user handle the narration they have seen up to and then, continue the narration by providing their ratings.

With the help of Smart Game Format (SGF), which provides a written description of move sequences, (Ciolino, Kalin and Noever, 2020) have trained the Generative Pretrained Transformer (GPT-2) to play Go game like a pro. Results show that language modelling is capable of capturing both the strategic formations and the sequencing pattern of championship Go games, and that random play takes undesirable beginning locations, like as the board edges and second rows, hence there are some obvious differences between random and Go transformer play that may be attributed to training. The resulting model generates a nearly complete and coherent game sequence without any human knowledge, heuristic rules, or strategic guidance.

Automated tale creation employing a computational model of focalization and several plan libraries for the story's characters were studied in (Author, 2011). By telling the same tale from numerous angles, multiple internal focalizations can provide complex events with rich and varied explanations. However, because of the repetition, it can also weary the audience or reader.

3. Methodology

A. The Population, Qualitative and Quantitative Research
The population of users for the proposed state-of-art text generation model solution included:

- All 5 to 6 years old.
- Preschool children.
- Childcare authorities.
- Children's storybook authors.
- Children's storybook publishers.
- Children's home wardens.
- Especially abled children.
- Their guardians.

The sample group was selected in multi-stage randomly. To gain a better understanding of the case study, a survey questionnaire was carried out. Out of the 171 responses collected, 91 responses marked a parent of at least one kid.

Number of Kids	Percentage of parents who responded (%)	Age of the Youngest Child	Percentage of the families who responded (%)
1	24.2	Less than 1 year	13.2
2	38.5	1-3 years	27.5
3	25.3	3-6 years	11
4	2.2	6+ years	48.4
5	9.9		

Table 1: Survey Statistics

As the result shows, the majority of families had two children. The findings for the questionnaire question on who remains with the youngest child in the household were then as follows:
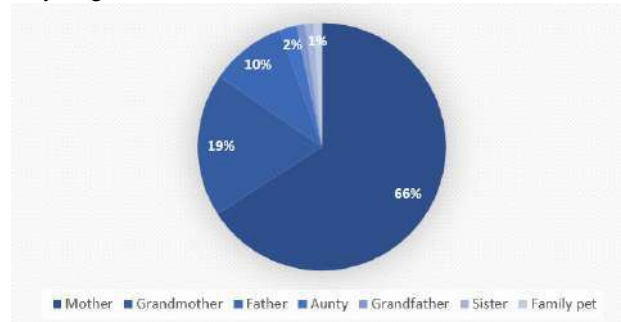

Figure I: Survey Statistics on "Who Stays with The Youngest"

This results in the mother of the child spending more time with the child, however working moms only have a noticeably short window of time to spend with their children. So, that causes a major issue when it comes to kids getting into tech autism, being violent, or less creative of perceptions and imaginations. interactions of the kid develop with the cause of time when the children spend more time with their family.

To build a case on the facts, the participants have answered regarding the behaviour of the youngest as follows,
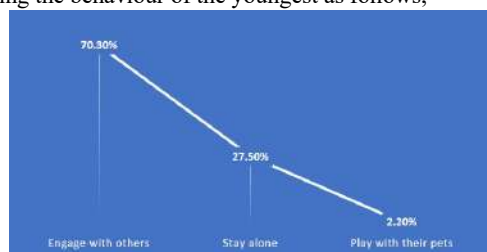
Figure II: Survey Statistics on "Children Behaviour"

As a result, the study found that children are more engaged with one another and had no problem reading books alone or listening to someone read aloud to them. But the kids who stay alone require some encouragement towards reading books.

Then the questionnaire also included responses on digital device usage of the kids in their families, and the results are shown as follows,
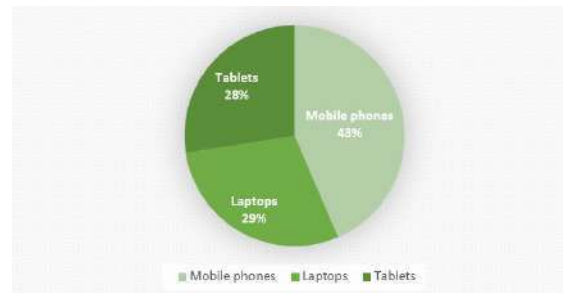
Figure III: Survey Statistics on "Digital Device Usage of Children"

This concluded with the fact that mobile phone usage was seen as an addiction on the benefit of the doubt.

The researcher also came across a campaign held by UNICEF at LAOS. This campaign was carried out by UNICEF because most schools have been closed temporarily due to the coronavirus pandemic which has hit hard on kids who are in the age group of 5 to 13 years of age.

It was able to niche down the captured observations where there was one specific kid who was affected with tech autism. The research was able to gain observation on him as:

- Child only reacted to a set of specific keywords.
- Child has fewer interactions with strangers, but better interactions with parents and siblings.
- Children have a good sense of knowledge of tech devices, and they are fast learners and identify patterns.
- Child understands English and Sinhala language and is interested in reading stories about princesses, and books with large pages and illustrations.
- Child shows aggressiveness when there is a situation that carries out a big noise but is affectionate to animals.

Following identifications were abstracts from the UNICEF at LAOS read-out loud campaign.

- Children happen to read more stories and actively engage in them when the stories are in their native language, and they have improvement of the use of their language over the cause of time reading.
- Parents happen to encourage children to read more English stories and keep them engaged with educational activities without considering the pandemic.
- The age group of 5 to 8-year-olds' parents tend to read stories to children than children read them by themselves

The researcher was able to draw meaningful conclusions from the observations stated above, having a substantial influence on the study endeavour. The event planning of the event has been aided by the children's and the kid with autism's recognized behaviour. The modelling process needs to create a universal application that can be utilized by any youngster, whether or not they have tech autism, who belongs to the target audience of users. As per the conclusion of the observations and the questionnaire, it was able to form a model to cater to the target audience's requirements. A high-level abstraction, a genre/theme-wise story generating an application with the ability to generate stories based on starting statements. And to support the Sinhala language to satisfy the native language readers and listeners in Sri Lanka.

4. Design and Implementation

With the completion of the entire project on python3, react was used as the frontend framework to produce the graphical user interface for generic users. GPT-2 model was trained on amazon web services to deploy the trained model on google drive in order to fetch it with google colab to present the proof-of-concept for state-of-the-art text generation.
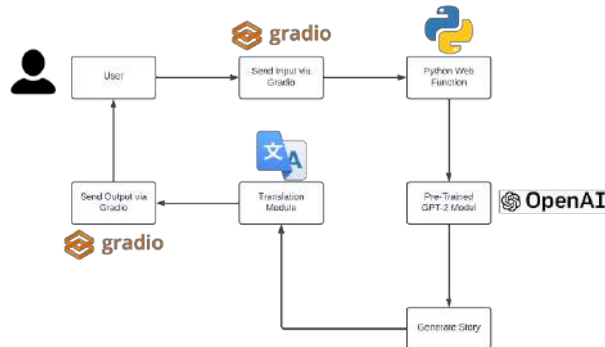
A. Overall System Architecture

Figure IV: Overall System Architecture

The proof-of-concept application was built on google colab environment. When utilizing the Gradio online interface, the user is given the option to choose a genre, topic, or an opening statement. The chosen input feed is then sent to the trained model, which was trained using Amazon Web Services, to produce a series of tales that are then returned to the output environment. The created tale is placed into a collection of English language stories, and using the Google Translator API, it is translated into Sinhalese. Both tales may be produced and sent to the user for recitation.

B. Implementation Plan

To achieve the aims and objectives of the development by sprints, implementation was carried out in an agile way, and the research component took the bulk of the time for project preparation.

The research process is broken down into seven steps.

Step 1: Form up a suitable dataset

Step 2: Finetune the GPT-2 model into children's stories

Step 3: Train the fine-tuned model in the AWS environment

Step 4: Generate children's stories based on the dataset formed up

Step 5: Translate the generated stories into Sinhala using Google translator API

Step 6: Enabling text-to-speech synthesis for special-abled children

Step 7: Evaluate the generated text output

The formation of the dataset was the most critical task of the study to validate the proof-of-concept. When gathering the dataset, it is important to pay attention to the details of the context and the vocabulary that has been used in the datasets. Length, credibility, and the language vocabulary of a story are the key points to focus on.

After that, it was able to go through some other datasets that are available outside which have been already used in similar studies. Facebook researcher dataset, Shakespeare stories dataset, Rick and

Morty stories dataset, hugging face story merge dataset, and fellow researchers' dataset were thoroughly studied.

Later, a few datasets were dropped due to the reasonings of:

Dataset	Removed /Selected	Reason
Facebook researcher	Removed	Volent and racist words
Shakespeare stories	Removed	Contains high profile words which are not easily understandable by a child
Rick and Morty Stories	Removed	Contains mismatch data in between
Hugging face story merge	Selected	Continue to proceed with
Fellow researchers' dataset	Selected	Continue to proceed with

Table 2: Datasets

Figure V: Facebook Dataset

Figure VI: Fellow Researcher Dataset

```
First Citizen:
Before we proceed any further, hear me speak.

All:
Speak, speak.

First Citizen:
You are all resolved rather to die than to famish?

All:
Resolved. resolved.

First Citizen:
First, you know Caius Marcius is chief enemy to the people.

All:
We know't, we know't.

First Citizen:
Let us kill him, and we'll have corn at our own price.
Is't a verdict?

All:
No more talking on't; let it be done: away, away!

Second Citizen:
One word, good citizens.

First Citizen:
We are accounted poor citizens, the patricians good.
What authority surfeits on would relieve us: if they
would yield us but the superfluity, while it were
wholesome, we might guess they relieved us humanely;
but they think we are too dear: the leanness that
afflicts us, the object of our misery, is as an
inventory to particularise their abundance; our
sufferance is a gain to them Let us revenge this with
our pikes, ere we become rakes: for the gods know I
speak this in hunger for bread, not in thirst for revenge.

Second Citizen:
Would you proceed especially against Caius Marcius?

All:
Against him first: he's a very dog to the commonalty.

Second Citizen:
Consider you what services he has done for his country?
```

Figure VII: Shakespeare Dataset

And the following observations have been carried out regarding the selected datasets.

- Stories have no same length
- Storied happen to be untrue sometimes
- Stories happen to have different characters on the ongoing
- Stories happen to have genres that are quite out of the league for the kids
- Generating a native translation of the stories could be challenging

C. Setting the Development Environment & Finetuning the Model

To carry out the development procedure, Google Colab notebook environment was selected as it requires no prior installation or configurations and provides GPU, CPU, and TPU runtime environment free of charge to proceed with the coding. And also, it supports Python, and its libraries and faster runtime environment access are needed to host the Jupyter notebook to carry out heavy coding without crashing the browser.

The development process included a few more libraries along with Python which are: transformers, GPT-2 simple, Gradio, and Google trans. And the gradio was used for the development of the Python web interface.

GPT-2 model was trained by feeding the selected datasets to get better results from the state-of-art text generation. The final model

was 1.32GB in size when the finetune was the end. Amazon web services provided by The AI (Artificial Intelligence) Team (Pvt) Ltd were given the ability to train the model without causing any challenges on the computing power.

Finally, the python web interface was developed using Gradio library.

5. Results

The transformer module was evaluated to see if it was successful in optimizing for the generated table. To test the transformer-based GPT-2 module, multiple values were assigned to the parameters, which were then fine-tuned numerous times to produce cohesive tale material.

The output material had several pointless phrases of information plagiarized from the internet as well as numerous variations on the story that was being taught. The effectiveness of the deep learning module in preventing overfitting of the input training data was also examined.

After some tweaking and adjusting the dataset filed to see how the GPT-2 module behaved, the goal of a cogent creative narrative construction without underfitting or overfitting was attained. This was caused by the GPT-2 transformer model's auto-regressive function. As a result, it was able to extract two tidy instances of stories from the dataset that it had learned.

A. Translating Into Sinhala

The process of translating the story from English to the Native Sinhala language was tested and evaluated.

	English Text	Sinhala Text
Case 01	Once upon a time there was a little prince who loved adventurous travel. But one day his father said, "Son, you must not go anywhere without your father's permission." He sadly fled in search of something. But after a while, he started to get into trouble. The king sent his army and ordered them to return home. So, he went back home and promised never to disobey him.	ඉ සජනක ගමන් බිමන් වලට ප්‍රිය කරන පුංචි ගමාරයයක් එක කායලක හිටියා. නමුත් දිනක් ඔහුගේ පියා පැවහයේ "පතා, ඔබ ඔයේ පියායේ අවසරයකන් යතාරව යකාය ලේවත් යන්න එපා" යනුයවනි. ඔහු දැයකන් යමක් යසායමඟින් පලා ගියේ ය. ඒත් ටික දවසක් යන යකාට එයා අමාරුයයේ වැයටන්න ගතෝතා. රජු තම මුදාව යවා ඔවුන්ට ආපහ යගදර යන යලස අණ කය යෙ‍රී ය. ඒ නිසා, ඔහු ආපහ යගදර
Case 02	Cats and dogs. "The dogs were catching and playing," he said. Then she caught a scorpion in her claws, and she ran away. "" What did she do to you? "I asked." She bit you with her teeth. "" Did she bite you with her	බ ලුන් ස බල්ලන්. "බල්යලෝ අල්ල යගන යසල්ලම් ක �‍රා," ඔහු පැවසය. එවිට ඇය යගෝණුයසේයසඟ ඇයේ නියයපාතු වලට හ වූ අතර ඇය පලා ගියා ය. "" ඇය ඔබට කය යෙ‍රී ගමක් ද? "මම ඇහවා." ඇය ඔබව ඇය ඇයේ නියයපාතු

| | claws? " "Yes," I said. "She bit your clothes. She bit your teeth." He asked. "Yes," I said. "She bit them on your clothes. She bit your teeth | වලින් ඔබව සපා කෑවාද? ""ඕ," මම බයවෙමි. "ඇය ඔයේ ඇඳුම් ප∶ා කෑවා ය. ඇය ඔයේ දත් ප∶ා කෑවා ය." ඔහු ඇහුවේ ය. "ඕ," මම බයවෙමි. "ඇය ඒවා ඔයේ ඇඳුම් මත සපා කෑවා ය. ඇය ඔයේ දත් සපා කෑවා ය. |

Table 3: Translation Testing

According to the generated outcome, it shows that the translation has been successfully done in both cases yet few grammar issues along the context.

The integration testing was carried out after the transformer0based GPT-2 model was integrated into the Python web interface application. The values were entered into the system and the correlation between the user inputs (theme, prompt keywords) was assessed quantitatively. The pipeline ran successful measures showing the integration testing has passed for the implemented system.

6. Conclusion

The novel approach discussed in the research study depends on the dataset that is being used to implement the system.

To continue the further development, it is required a system with higher RAM capacity to finetune the GPT-2 model in advance. Children love interactive stories consisting of several imageries and lesser texts. Such as Disney movies, ice age, how to train your dragon, Moana, Garfield. Including imageries to the implemented system has been restricted due to GPT-3 model not being available for public usage.

Story generating system discussed in this research study evaluates the results through a web application using AI (Artificial Intelligence) based on RNN. For future development finding relevant Sinhala datasets and implementing the Sinhala web application, test and evaluate the sentences in the resulted story datasets to be grammatically corrected and include image generation in the stories that are generated.

In this study, GPT-2 model was used to generate the kid-centric stories. The use of the GPT-3 model in future work will stand better for the image generation along with the text generation. With the imagery generation the application will be more appealing and able to reach more audiences of children.

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Abbreviations and Specific Symbols

DL	Deep Learning
RNN	Recurrent Neural Network
NLP	Natural Language Processing
AI	Artificial Intelligence
S2S	Sequence to Sequence
LSTM	Long Short-Term Memory
FGS	Folktale Generator System
NLG	Natural Language Generation
GPT-2	Generative Pretrained Transformer
SGF	Smart Game Format

Table 4: abbreviations

Acknowledgment

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Multilingual Learning Platform for Kids to Learn Foreign Languages in Sri Lanka

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Abstract: *Learning and teaching a foreign language is not easy. It is not challenging if it is practiced from childhood. This research paper mainly considers which age range of students will be helpful and scrutinizes the attitudes of parents and teachers of the foreign language learning tools. The main aim is to achieve the initial steps when developing a foreign language learning tool for kids. For that, the researchers have surveyed to gather information about the students who are learning foreign languages and those who are willing to learn. And also to find the most popular foreign languages that are used in Sri Lanka, find the difficulties that occur when following these languages, and find methodologies that can be used to improve the language learning skills of small children and mitigate the time constraints and students' shyness in learning Foreign Languages.*

Keywords: *Foreign languages, Learning tools, kids language learning interests, Multilinguism*

1. Introduction

A language is deemed international if it is primarily taught in the school and is not being spoken in the place where it originated. And also, foreign language teaching and learning contexts have shifted from traditional classroom teaching methods to student-centered learning methodologies. The acquisition of other languages enables the persons to share information successfully and freely, as well as engage in real-life scenarios, using the vocabulary of the native culture directly. Multilingualism allows exposure to some ideas distinct from others, improves one's power to detect linkages across different topics, and encourages an integrative viewpoint while acquiring global knowledge and skills. Foreign language pedagogy is tutoring a formal language that is neither the primary nor native language of a large portion of the population. Academics devised instructional techniques and learning contexts that involved students in dynamic communicative language tasks based on linguistic principles, research methods, and practices. There is sometimes a difference drawn between second and foreign language acquisition. The acquisition of a second language demands that the student dwells where the gained language is being spoken.

In this research paper, the researchers have discussed the percentages of the students who are following and not following foreign languages. From the survey, it can be categorized according to the age range and the languages that the children are learning. Preferred kinds of languages of the children who do not follow any languages at the moment by learning in the future. Furthermore, this research paper includes the perspectives of parents with children from the ages of two to nineteen and educators teaching foreign languages. And also, the researchers have collected ideas, suggestions, and recommendations to consider from both the parents and teachers when developing a foreign language tool for kids because, in Sri Lanka, most children do not know foreign languages other than English. The researchers are trying to identify the cautions for not selecting to study some foreign languages and come up with a solution for the problems and difficulties faced by the students, parents, and teachers when learning and teaching foreign languages.

2. Literature Review

The research (Awan et al., 2010) highlights anxiety in English undergraduate classrooms in terms of the kind of events that cause stress at various phases of the curriculum, as well as the link between anxiety and learners' accomplishment. Furthermore, students' GPA in English courses is examined to determine its association with language anxiety. The findings demonstrate that linguistic stress and performance are inversely associated. It's been discovered that female students are less worried than male students when studying English as a foreign language. The most common source of concern is speaking in front of people, followed by fears of grammar faults and pronunciations.

According to the research (Fryer and Carpenter, nd), Foreign Language Learning (FLL) students commonly have few opportunities to use their target language. Teachers in FLL contexts try their best to offer possibilities within the class through pair or group work. Still, several reasons such as time constraints, awkwardness, or a lack of opportunities for appropriate support prevent this. This study examines the possible role of online chatbots in

meeting this demand. Chatbots might give students a way to practice their language skills at any time and in nearly any place.

The researchers in the study (Golonka et al., 2014) review evidence regarding the efficacy of technology in the foreign language (FL) acquisition and instruction, emphasizing empirical research that compares modern technologies with more conventional techniques or materials. Automated voice recognition (ASR) is based on computer-assisted pronunciation instruction research. These experiments proved that ASR might make things more accessible.

The researchers (Guetl et al., 2013) sought to investigate and build an environment that uses Web 2.0 technologies and online language learning tools to deliver a more integrated language learning environment. This research will examine technology and give information on how the tools can be integrated to provide language learners with a more productive working environment. A first working proof of concept based on this approach is promising, supporting modern language requirements, and the first findings and space for improvements are discussed.

This research analyses (Habók and Magyar, 2018) Language Learning Strategy (LLS) utilized with foreign language demeanor, capability, and joint school accomplishment among lower secondary students in 8 to 5 Years in Hungary. The main objective was to supply a complex diagram of these estimation points and to look at how Language Learning Strategy can support children within the first stage of the language learning process.

The study (Nghi, 2020) examines bots as a medium for foreign language learners in foreign language education. It explores the possible function of bots in deploying for instructing English as a foreign language to replace the time gap and individuals' timidity in acquiring English as a Foreign Language. The fundamental perspectives demonstrate how studying a foreign language with a bot is much more efficient when training with a foreign language instructor. Even though the condition of chatbots during foreign language instruction has received minimal prominence, learners are interested in this type of advancing technology. The research paper conveys the impact of using bots in language education with practical scenarios for lessons and provides recommendations for future uses.

The research (Panagiotidis, 2018) explores technology's effectiveness as motivation in foreign language acquisition. The connection between the use of intelligent technologies such as online applications and services, computer games, mobile applications, or forms of communication and encouragement in the field of language teaching was thoroughly researched, using a range of techniques and

within the system with many language teaching and learning programs. Additionally, this article analyses the notion of encouragement in the academic domain and the link between technologies and language acquisition, highlights many of the various studies conducted by researchers on this matter, provides a summation of the works studied, and proposes a recommendation on how to use the modern technologies as a motivational factor for foreign language learning.

According to (Przygoda, 2017), the e-Learning course is a distributed system that combines socio-technical elements. Increasingly the technology networks of eLearning are becoming interconnected with the Internet. Language can be perceived in many ways by different individuals in various circumstances. As a result, it is critical to use terminology that is as exact and unambiguous as necessary. The fewer the alternative meanings for a statement, the more precise person's use of words becomes. It is critical to incorporate more engagement, animations, and multimedia; this can be a mash-up of details, facts, and figures blended and prepared on the computer with well-stated educational objectives.

The researchers of this research paper (Tsou, Wang, and Tzeng, 2006) have designed a multimedia Storytelling Web application to explore whether internet-based technologies may improve English language teaching and learning by using storytelling and narrative discussions and illustrating this Webpage's usefulness in considerably assisting kids' English language teaching and learning activities, it had been installed inside one primary school to verify its success in education and subsequent learning outcomes. The main aim is to produce multimedia tales easily, clearly, and quickly, even for teenage children, re-play and discuss the narratives created by someone in classrooms or at the house, showcase or study how storytelling may be linked to classrooms, and access the Service anywhere at any time.

3. Methodology

The researchers in this research paper have surveyed to collect data. The survey is mainly focused on three categories as parents and educators. The questions differ according to the user role of the survey. The primary purpose of dividing according to user roles is that it is helpful to get the results. The researchers have included both open-ended and close-ended questions to analyze better. This survey was distributed among 150 people, and the researchers got 94 responses.

4. Results and Discussions

The following Figure 1 indicates the three leading user roles the researchers have taken to conduct the survey. The

majority of the 60.2% are students. The other 28% are parents, and the rest, 11.8%, are educators.
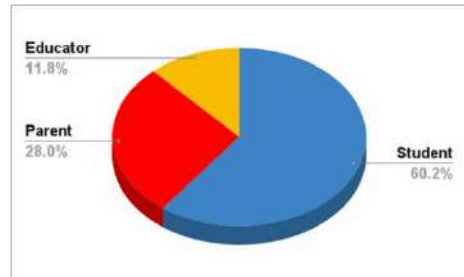

Figure 1. User Roles

One of the prominent user roles in this research paper is the parent. The following figures indicate the analysis of the results which were given to them.
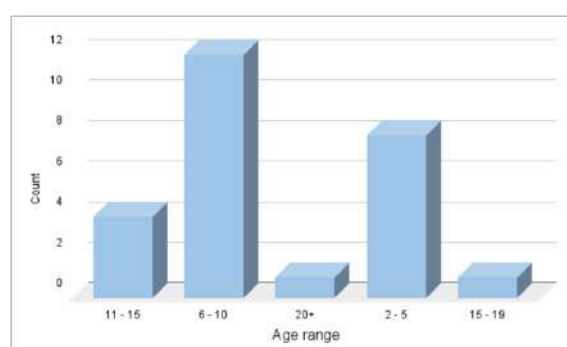

Figure 2. Age limits of the kids

The age limits of the kids of the parents are stated in Figure 2. 46.2% of the kids are from 6 to 10 years old. 30.8% of the parents have kids between the ages of 2 -5 years. Kids' ages eleven to fifteen have 15.4%, and 3.8% of parents have kids between 15 and above. Moreover, more than 80% of the periods mentioned above kids do not follow any foreign languages at the moment, and the rest of the twenty percent of the kids are learning some foreign languages.

Figure 3 indicates the languages of the children who are following any language.
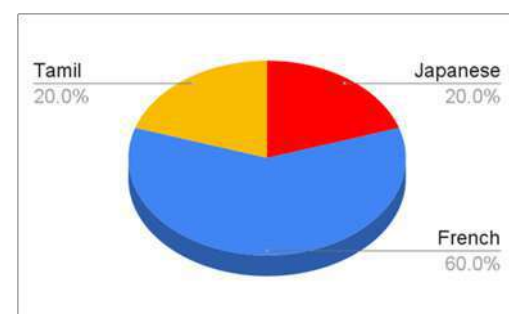

Figure 3. Languages that kids are learning

Most of the kids are learning French, and the other 20% are learning Tamil and Japanese. 60% of the total number of kids have learned the languages for more than a year, and the rest, 20%, have known for more than two years and three to five years. Most of the students who have learned

for more than two years are above fifteen. The students currently learning foreign languages are studied in private classes, and the remaining kids have learned the language from school. In Sri Lankan, most the schools have the facilities to learn foreign languages, especially French, Hindi, Japanese and Chinese. And also, students can select these languages for the Ordinary level and advanced level examinations.

The researchers have gathered information about the kids who don't follow any foreign languages and the hopes of their parents to teach foreign languages to their kids. According to the survey, more than 90% of the parents would like to teach foreign languages to their kids, and the other 10% neither like nor dislike engaging their kids in practicing a new language.

The graph in Figure 4 demonstrates the languages the parents have chosen to teach their kids who are still not following a foreign language. Most of the parents have stated that they are going to teach French language and German language for their kids, and also other than that, the parents would like to teach Spanish, Hindi, Chinese and Japanese for their kids.
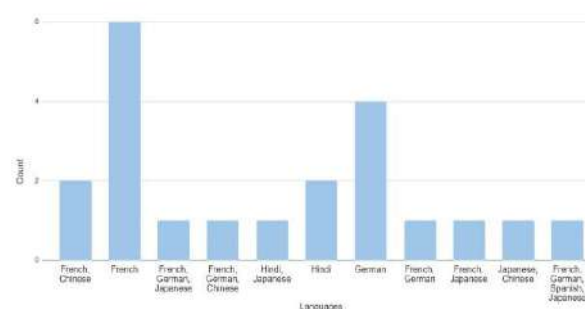

Figure 4. Preferences of parents on which languages to teach to their kid

Figure 5 indicates the parents' options to teach foreign languages to kids who don't follow any languages. More than 40% of the parents selected private classes to attend to their kids, while 28.6% of parents stated teaching by using online learning apps. Only 23.8% of parents liked private and online learning tools, and others chose YouTube to teach their kids.
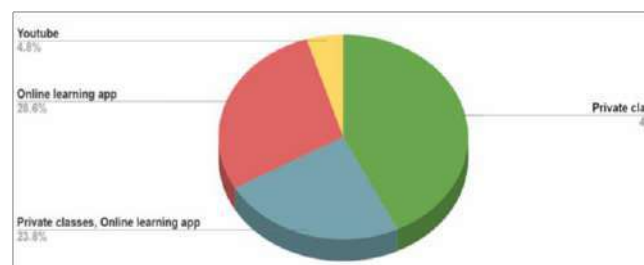

Figure 5. Methods chosen by parents to teach kids

Another prominent user role in the survey is Students. The researchers have collected the data and information from the students currently schooling and university undergraduates between the ages of ten to twenty-five years.
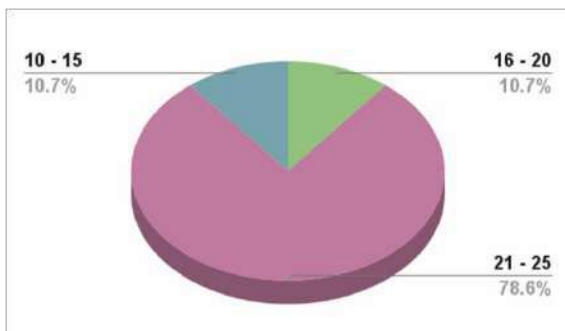

Figure 6. Student age limits

The researchers have mainly focused on high school students and undergraduates in the student category. In Figure 6, more than 78% of the students are between the ages of twenty-one to twenty-five years. The other 20% of students are in middle school and high school.
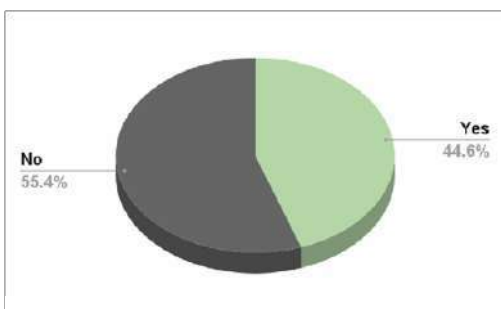

Figure 7. Students who follow foreign languages and who are not

Figure 7 indicates the percentage of the students who are following some foreign languages and those who do not follow any. Most students with fifty-five percent in the ages of ten to twenty-five have not studied any foreign languages and have surveyed that they would like to learn new languages. 44.6% of students have reviewed any of the foreign languages.

The languages that the students who don't follow any languages would like to learn are stated in Figure 8. The majority of the students want to learn French and German. There were other languages like Spanish, Hindi, Japanese, Russian, Chinese, and Korean. French and German are the most popular languages among school children.
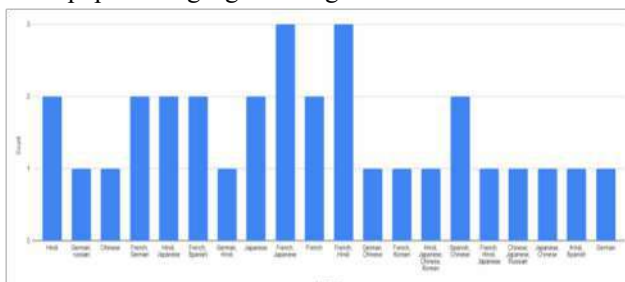

Figure 8. Preferred languages of the students

From the survey, the researchers have identified that 29% of students who still do not follow any foreign language course will like to attend private classes, and 35.5% of the students would like to learn a new language using a language tool. And another 29% of students like to learn through both private classes and the language tool. 6.4% of the students would like to study using YouTube and Alliance Francaise institutes.

The following Figure 9 shows the difficulties parents and students face when selecting to teach and study foreign languages.
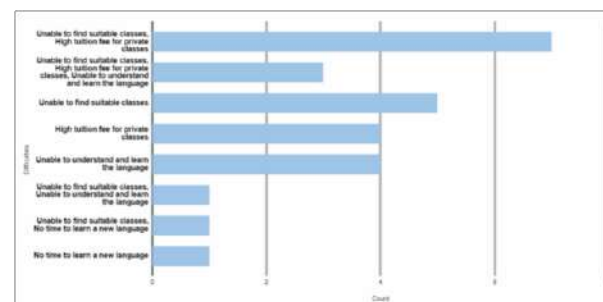

Figure 9. Difficulties when learning

Most parents have mentioned that the main difficulty is finding suitable classes for their kids. In Sri Lanka, most children and parents are not attentive to learning foreign languages except English. And also, a few students learn foreign languages, and the students who have learned the languages do not have suitable vacancies in the country. So they tend to migrate. Not having suitable classes in every district and the limited courses with many students may lead to not selecting the learning stream. Moreover, most parents said that the classes teaching foreign languages have a very high tuition fee, and most people cannot afford that. Some students have said that they don't have time to learn a new language and think they will be unable to understand and use the language properly.

Figure 10. Likelihood of the usage if propose an online learning tool

According to the Figure 10 majority of the people who have done the survey is like to use the online tool that the researchers have proposed.

Below, Figure 11 represents the languages recommended by the people to use in the foreign language learning tool. Some are French, German, Spanish, Hindi, Japanese, Russian and Chinese.
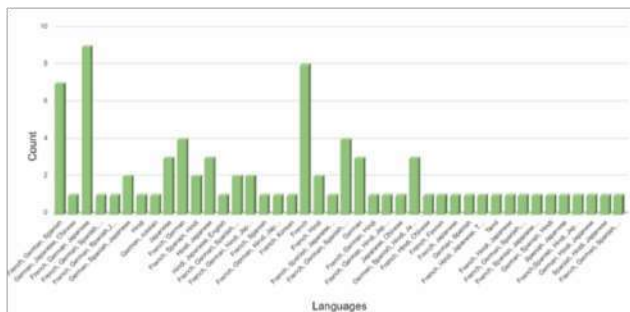

Figure 11. Proposed languages to include in the tool

There are a lot of suggestions to be included in the language learning tool proposed by the people who participated in the survey. Some of them are to categorize the activities and lessons in the language learning tool according to the age or from beginners to advanced steps, to include some exciting activities regarding the lessons to make them understand easier for the kids. They should be attractive and user-friendly as kids to use and also have more pictures, videos, and animations rather than a lot of text areas which are easily understandable and convenient for the kids, enable options to practice letters, numbers, grammar, and pronunciations in the tool, have some flashcards, quizzes, puzzles, and some games which keep the kids using the tool without any boring. And also, some have mentioned adding features like consulting teachers and direct contact via the tool. Moreover, the letters are somewhat challenging to write and memorize in languages like Chinese, Japanese and Korean. So, the people suggested adding the tool's letter practice modules. And also, it is stated that to include day-to-day words, some essential vocabulary, real-life conversations, and some cultural practices and traditional events. Clear audio, pronouncing the words like native speakers, and stating the phonetics are other responses.

The following section includes the questionnaire sent to educators teaching foreign languages in Sri Lanka.
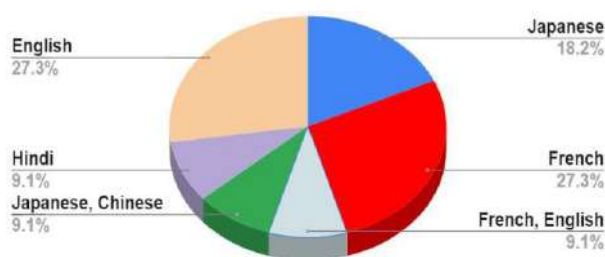

Figure 12. Subjects of the educators

Figure 12 shows the foreign languages that the educators teach. 27.3% of the teachers are doing French and English. 18.2% are teaching Japanese, and others teach Hindi and Chinese languages. Among them, 45.5% of the educators teach foreign languages for any age group. In comparison, 18.2% of the teachers teach only to students between the ages of eleven to fifteen and two to fifteen years. The rest of the educators are tech for the age groups of two years to ten and fifteen to nineteen years students.
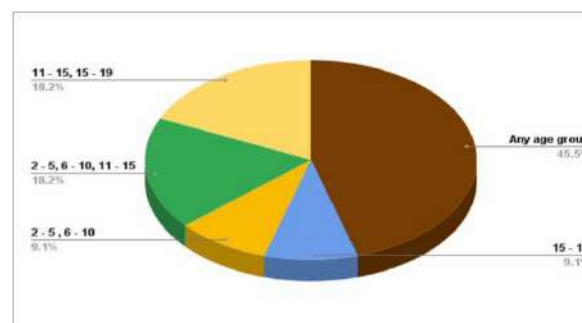

Figure 13. Age groups

Figure 14 indicates the teaching experience of the teachers who have participated in the survey.
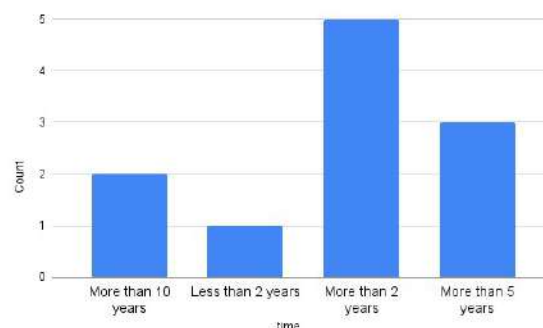

Figure 14. Teaching experience

The opinion of the teachers who are teaching foreign languages demonstrates the difficulties they face when teaching kids. Some have many kids in the classroom, and it is not easy to handle some students in the class. 71% of the teachers state that the kids use native languages when answering questions and communicating. It is challenging to teach some kids, and some don't concentrate on the lessons. Some educators demonstrate that some kids get bored and are not interested to learn the language. But some students are enthusiastic about learning and quickly understanding and getting used to the language easily at a young age. Lack of reference books with native language explanations for students' usage, Students show some hesitation when using the language in front of others are some of them. 91.7% of the educators recommend using the foreign language learning tools, while the other 8.3% of the teachers are going to recommend using the tool.

The educators' ideas and suggestions for the survey the researchers did are mentioned below. Make the learning tool more convenient for the kids and include attractive colours, pictures, videos, and animations to keep the kids using it. It will be successful because the kids love brain breakers rather than concentrating on the continuous lessons of the class. Make the interfaces simple and easy navigation system. Most of the teachers have stated to include lessons done by native speakers of these languages, accessible and attractive methods to practice characters and vocabulary, and practical sessions through conversations with native speakers. Successful because the kids love brain breakers rather than concentrating on the continuous lessons of the class. Make the interfaces simple and easy navigation system. Some of the teachers have stated to include lessons that are done by native speakers of these languages, easy and attractive methods to practice characters and vocabulary, and practical sessions through conversations with native speakers of the language.

5. Conclusion and Future Work

Living in a multicultural and multilingual world where communication is more crucial than before. The world is growing more international, and learning a foreign language may always provide an unexpected opportunity. Becoming multilingual has significant advantages. A foreign language may significantly impact one's job because people live in an interconnected society, and greater careers offer opportunities where understanding more than one language is required. Learning a foreign language may provide a sense of diverse societies in addition to increasing the possibilities of building a successful career or succeeding in the profession. People will be more equipped and enthusiastic about flying around the world and learning about other cultures and people.

Further, in this research paper, the researchers have surveyed and discussed the foreign language learning amount, age range, and the preferred languages to learn. Moreover, in future work, the researchers have proposed a system to learn the languages step by step from the beginning. This includes the basic areas of the language, which can be used by any age range. It also facilitates the study of grammar, spellings, tenses, and pronunciation which will be a little bit advanced in the language. After each step, a small quiz will enable the user to go to the next level. The users can get the progress of the learning and monthly reports of the learning. And also, the researchers hope to include a translator module in the proposed system.

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Speech Emotion Recognition for Autism Spectrum Disorder using Deep Learning

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Abstract*:Children who belong to autism spectrum disorder have difficulty identifying emotions and expressing their emotions. Because it is hard to identify the emotions like anger, disgust, fear, happiness, neutral, sad, and surprise in other people and themselves. This can be even more severe when it could not be found at the beginning and may lead to impairment of social communication of the child. Through the proposed systematic methodology child can identify their basic emotions and try to express them. This evolved methodology was developed using python language. For emotion recognition used a deep machine learning model like Recurrent Neural Network (RNN) using Keras with a TensorFlow backend. RNN consists of four layers with two long short-term memory (LSTM) layers. To optimize the performance of the model used Adam optimizer. For the training and testing of the model used online available data. For the classification of the emotion's valuable features of the audio signal like Zero Crossing Rate (ZCR), Chroma STFT, Mel- Frequency Cepstral Coefficient (MFCC), Root Mean Square (RMS) value, and Mel spectrogram are extracted using the python libROSA library. Due to the lack of the data amount and GPU requirements model's performance can be decreased. This model performed well with the TESS data corpus with 91% test accuracy.*

Keywords*: speech emotion recognition, autism spectrum disorder, ZCR, Chroma STFT, MFCC, RMS, Mel spectrogram*

1. Introduction

Autism Spectrum Disorder is a neurological disorder that mainly affects children's development. Children may show less communication and social interaction, restricted interest, repetitive behaviours, and mannerisms due to this disorder ("Psychiatry.org - What Is Autism Spectrum Disorder?"). It has been widely known that the connection between the brain and behaviour neurological disorder is affected in those who have autism spectrum disorder. The disorder may affect the brain's structure and function, which may lead to the symptoms. There is no cure for autism spectrum disorder, but there are treatments to help manage and improve the symptoms ("Autism spectrum disorders,"). Historically, autism was thought to be caused by bad parenting, but today it is founded that autism is a complex disorder. It is not one thing, but a group of symptoms that

can only be understood in the context of the person who experiences them. Over the past few decades, discovered a lot about autism and have begun to understand that it is not a single disorder, but a group of related disorders that share symptoms, diagnosis, and treatment. One of the primary causes of autism spectrum disorder is the environment in which a child is raised. It is a complex condition that requires multiple interventions to help improve a child's social and communication skills. Because of the complexity of ASD, effective treatment requires a multi-component approach. It is estimated that 1 in 68 children in the United States has autism spectrum disorder, making it one of the most common disorders among children ("Autism spectrum disorders,"). Many parents and educators have become concerned about the rise of autism spectrum disorder, especially among boys, and have called for greater research on the causes and potential ways to prevent it.

Once a child is diagnosed with ASD, parents are faced with the difficult task of finding the best ways to help their children. The first step to helping a child with ASD is to find the right specialist. This can often be frustrating because there is a wide variety of specialists that are available to help. Special people in this field like paediatricians and speech therapy pathologists help people with ASD to overcome challenges in their communication skills, while others specialize in behaviour modification, helping individuals with ASD to manage their behaviour so that they can function in a classroom or work environment. When considering a country like Sri Lanka, where there is a high prevalence of autism spectrum disorders, it is crucial to have a system in place that is designed to help individuals with ASD. One of the most difficult things in our country is that there is a lack of services for individuals with ASD ("Autism spectrum disorders (ASD) in Sri Lanka,"), making it difficult for those with the disorder to get help and support that they need. This often causes families to take a do-it-yourself approach to help their children, which can be ineffective and cause more harm than good. One of the most effective ways to help an individual with ASD is to provide them with the professional support that they need.

Today, some researchers turn to advanced technology, like machine learning, to detect ASD in children because some symptoms are hard to detect by the parents especially in young children's because they may not have obvious symptoms, making it difficult to know when to refer the child to a specialist. Therefore, new technology, like

machine learning, can help diagnose ASD earlier, improving access to care for those with the disorder. Machine learning has been used to detect ASD in children with high sensitivity and specificity, but to do so, the algorithm needs a large amount of data.

This paper is structured as follows: Section 2 describes the related works which cover the research topic, section 3 presents the methodology, section 4 presents the conclusion, and section 5 presents the future work.

2. Related Works

Most of the previous works are based on speech emotion recognition (SER) but some are based upon automatic speech recognition (ASR) to detect the autistic symptoms of the child's speech. Works based on the ASR are still in a developmental stage and there are still many challenges to be solved in this direction. The main challenges are, firstly, automatic speech recognition is still a new field of study and there is still much to be learned from the existing works. Secondly, such kind of speech recognition can only be performed when the software has enough background information about the language and the speaker. In this paper, speech emotion recognition is addressed.

The researchers (Rouhi et al., 2019) have developed a website to identify the emotions such as happiness, sadness, anger, and neutrality of ASD children with two. The first part is for learning and the second part is for checking the child's performance. Then the child must express the assigned emotion using the tone of voice. To classify this emotion first audio is extracted to avoid the noise contained in the audio. Then extracted the MFCC (Mel-frequency Cepstral Coefficient). Then those extracted features are passed to the random forest classifier to classify the emotion in the audio. This model achieved an average accuracy of 72% over five independent runs. The specialty of this model is that can predict emotions in more than one language. Another study (Matin and Valles, 2020) developed a speech recognition model which identifies emotions in social interactions. Python LibROSA library s used to extract the features from the recordings. After extracting MFCC Zero Crossing Rate (ZCR) extracted because it increases the test accuracy of the utterance when noise is contained in audio. Used grid search for the SVM model and 48,000 Hz frequency as the native sampling rate to process the utterances. Achieved test accuracy of 77%. But overfitting due to the lack of audio recording used to train the model. Another study developed a tool to identify a youngster's proper emotion while the child is speaking (Welarathna et al., 2021). The children's input audio stream was normalized into a specified range, sub-framed into 2s duration for language-independent, noise reduction, and age independence features, and the most effective 40 audio characteristics were extracted. Even in an uncontrolled setting, the CNN-based model distinguishes eight different emotions; sad, disgust, surprise, neutral, happy, calm, fear,

and furious with an accuracy matrix of F1 score of 0.90. The trained model is capable of handling tiny frequency fluctuations in categorizing emotions.

The game developed by researchers (Heni and Hamam, 2016) is a different kind of research because it identified emotion via facial emotion recognition by analysing the facial expressions of the user. After that voice recognition is used. This educational game "Worlds of Kids" identify mobile users' emotions via facial detection to extract the best appropriate and favourable game. These game developers paid more attention to the user interface because these designs are for ASD children. The game evolves with emotion recognition, ASR which integrates the deviation in emotional sounds with three distinctive degrees of intensity. After the notion of synchronization presents the emotional speech, facial emotion recognition. This game can measure emotions with an average accuracy of 87%.

However, the current works use advanced ASR software and machine learning techniques to detect the symptoms of the child with ASD. The researchers use deep learning methods, such as the convolutional neural network, to achieve the detection of speech emotion and fidgeting gestures. The biggest challenge in this area is to detect autism while the child is communicating with the other person in a normal way. Some use machine learning techniques to detect autism while the child is communicating in the normal way. Following research used ASR to identify the symptoms of autism.

A two-stage system was developed to identify articulation disorders and learning assistive systems for acoustic children (G Pillai and Sherly, 2017). Articulation disorder is based on the 14 Malayalam vowels. Deep encoder used for pre-training with several features including MFCC, ZCR, etc. LASAC is used to provide speech training, speech analysis, and articulation tutorial. This system achieved 65% of accuracy with the autistic dataset. Tianyan Zhou et al., have developed an automated assessment framework to assist clinicians in quantifying typical prosody related to ASD. Used SVM to extract utterances level large dimensional acoustic features using OpenSmile toolkit. Then used a deep neural network to model the typical prosody label from the speech spectrogram. This system can predict the atypical prosody score for young children with the severity of ASD. Another study developed (Pawar et al., 2017) Automatic analysis of the LENA recordings system which can classify the recording of the people who are suffering from autism which are recorded in controlled home and clinical environments to child and adult vocalization. For pre-processing of the recordings Hamming windowing method is used. MFCC low-level features like deltas, double-deltas, pitch statistics, and a few additional features are extracted in the feature extraction. For classification Support Vector Machine (SVM) was used. This vocalization detector can detect both child and adult vocalizations at high precision and recall. To identify the speech deficiency of ASD children another study

developed a machine learning-based automatic speech analysis tool for the Sinhala language (Wijesinghe et al., 2019). The first stage of this system utilizes thresholding for silence detection and vocal activity detection. The recurrent algorithm is used to segment long audio files. Vocal filtration is applied to the segment labels which are not silent to relabel vocal audios as vocal and non-vocal audios as noise. After the first stage to classify the utterance into seven categories used CNN which gave 79% training accuracy and 78% testing accuracy. Also, provide high precision accuracy of 86%. Then these classified utterances send to another CNN network to check the presence of the autism traits. This gave 90% of training accuracy, and 72% testing accuracy but the average precision nearby 58% due to the limited training dataset. A special Cognitive-based intelligent learning assistant was developed to provide suitable courseware by identifying the child's specialty by analysing the behavioural patterns of the child (Vijayan et al., 2018). To analyse a child's specialty the author not only considers the child's real-time responses but also behavioural, medical, genotype, and phenotype data with brain and facial images. This system is based on the deep learning and prediction method. In the input, a layer chatbot is used to interact with the child either directly or in speech. Then using ASR is used to convert this speech to text and NLP is used to process text data. For images, classification can be done with high accuracy using a Convolutional neural network. Therefore, the brain and facial images which are taken using visual aid are classified using CNN and R-CNN (Regional Convolutional Neural Network) respectively. To suggest the courseware for the child author used reinforcement learning and a deep Learning algorithm. Predicting the autism severity through speech recordings is another accomplishment achieved in this area. The researchers (Eni et al., 2020) used voice recordings of Hebrew-speaking children who completed an Autistic Observation Schedule (ADOS) evaluation to extract arrange of prosodic, acoustic, and conversational aspects. The recordings of 72 youngsters yielded sixty characteristics, 21 of which were strongly linked with the children's ADOS scores. This was developed using multiple DNN methods to predict ADOS scores based on these variables and compared their performance to linear regression and support vector regression models. Among them, the convolutional algorithm produces the best results. When trained and evaluated on several subsamples of available data, this method predicts ADOS scores with a mean RMSE of 4.65 and a mean correlation of 0.72 with genuine ADOS scores. Automated algorithms that can reliably and sensitively predict ASD severity have the potential to revolutionize early ASD detection, symptom severity measurement, and treatment efficacy evaluation.

3. Methodology

This research involves developing a speech emotion recognition model to detect Autism by using children's emotional speeches. By taking the real-time recording of the child who is capable of verbal communication for emotion according to their preferences analyse whether they can express the feelings correctly within the given time.

A. Dataset

For the training and testing purpose of the model used the Ryerson Audio-Visual Database of Emotional Speech and Song (RAVDESS) and the Toronto Emotional Speech Set (TESS). RAVDESS contains 1,440 audio files in the carrier phase "Kids are talking by the door," and "Dogs are sitting by the door" of 24 actors (12 male actors and 12 female actors) and 60 trials from each actor. Phrases are pronounced in a neutral North American accent. Speech emotions include calm, happy, sad, angry, fearful, surprised, and disgusted expressions. There are two emotional intensity levels (normal and strong) and one neutral expression created for each expression. The audio was captured in WAV format at a sample rate of 48,000 Hz and a bit depth of 16 bits. TESS contains a set of 200 target words in the carrier phrase "Say the word _," and recordings of the set evoking each of the seven emotions were created (anger, disgust, fear, happiness, pleasant surprise, sadness, and neutral). There are a total of 2800 data points (audio files). All the audio files are in WAV format.

B. Pre-processing and Feature extraction

Pre-process the data set using data augmentation methods such as noise injection and changing the pith of the data. The objective is to make our model resistant to these perturbations and increase its generalizability. The label from the initial training sample must be preserved when adding the perturbations for this to work. When implementing this work into a real-world scenario the audio file may contain some Gaussian noise which should be removed from the audio file. Therefore, framing is essential for audio pre-processing. The speech signal is continuously changing over time. Splitting the audio signal allows the audio signal to become static. Usually, this audio frame is 20-30ms long, but this can depend on the author of the system. These frames are adjacent to each other to ensure no loss. This online available data set is already framed using necessary algorithms. Therefore, we only apply noise injection and change the pitch of the data as pre-processing steps.

After performing the data augmentation feature extraction took place. This model is not able to process audio files directly therefore instead of the whole bunch of the audio files it extracted some valuable features of the audio signal and then trained the model. Features can be identified through the different relationships of the audio files. We extracted features like Zero Crossing Rate (ZCR), Chroma STFT, Mel- Frequency Cepstral Coefficient (MFCC), Root Mean Square (RMS) value, and Mel spectrogram. for the extraction of these features used the python libROSA library. ZCR is the speed at which a signal switches from one sign to another, from positive to negative, or vice versa. Both voice recognition and the retrieval of music information have made extensive use of this characteristic. Typically, highly percussionist sounds, like those found in metal and rock, have higher values (Doshi, 2019). MelFrequency Based on the linear cosine transform of the

log power spectrum on a nonlinear Mel scale frequency, cepstrum is a representation of the short-term power spectrum of a sound. MFCC is a valuable feature in ASR implementations (Paulin et al., n.d.). Chroma STFT The Chroma esteem of a sound essentially speaks to the escalation of the twelve pitch classes that are utilized to ponder music. They can be utilized within the separation of the pitch course profiles between sound signals. Mel spectrograms visualize the visual representation of the frequency of the given signal.

C. Classification
For the classification of each emotion, we used Recurrent Neural Network (RNN) model which is effective for long sequence data or natural language. This model is a fully connected four-layer neural network. All the extracted features are saved and after that normalized and split the data set for training and testing. Speech is classified into seven categories such as anger, disgust, fear, happiness, neutral, sad, and surprise. The model used a fully connected four layers neural network. Added two LSTM (Long Short Term Memory) layers for the first layer and the first hidden layer. Based on accessible runtime equipment and limitations, this layer will select diverse executions (cuDNN-based or pure-TensorFlow) to maximize the execution. On the off chance that a GPU is accessible and all the contentions to the layer meet the prerequisite of the cuDNN bit, the layer will utilize a quick cuDNN usage. There are two hidden layers which consist of 128 neurons and one layer used the ReLu activation function. For the output, the layer user has seven neurons because emotions categorize into seven categories. Therefore, we used SoftMax as the activation function of the output layer. There is a Dropout layer with 0.3 dropouts in between the last hidden layer and the output layer. Dropout could be a regularization technique for neural organize models. It may be a strategy where haphazardly chosen neurons are overlooked amid preparing. They are "dropped out" haphazardly. This implies that their commitment to the enactment of downstream neurons is transiently evacuated on the forward pass and any weight upgrades are not connected to the neuron on the reverse pass. For the optimization used Adam optimizer for the model. Adam is an optimization calculation that can be utilized rather than the classical stochastic slope plummet strategy to overhaul organized weights iterative based on training information.
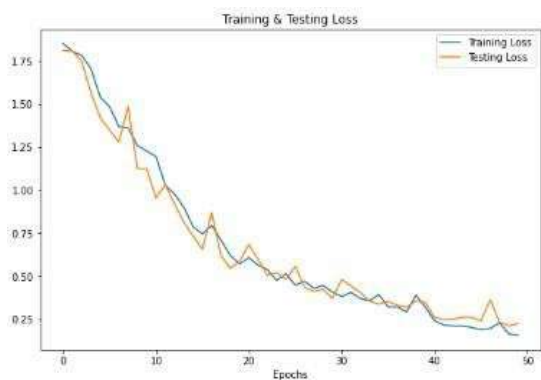
Figure 1: Model loss for Tess training and testing data

Figure 2: Model accuracy for Tess training and testing data

D. Results
After setting up and training the model when it tested for the testing data the accuracy of it is for the TESS data corpus is 91% with a 0.25 loss percentage after fifty epochs.

4. Discussion

When we applied the same model to the RAVDESS data corpus the accuracy of the model decreased by 50%. Then we go with the CNN model then the accuracy increased but it is not satisfactory. These arose because of the amount of the corpus as well as the performance of the model. Therefore, we only consider the TESS data corpus. For the testing of the model, we took the random amount of data set from the data set, because of the lack of data in our country and the difficulty in collecting data. This proposed methodology applies to any autistic child who can verbally communicate.

5. Conclusion

Autistic children have poor communication skills. Some are unable to speak or understand the language. Others have difficulty reading social cues and expressing themselves. Many cannot interact with other people or follow a conversation. They often miss cues and do not understand others' emotions or intentions. Therefore, the proposed system used emotional intelligence to help autistic children communicate. Through this model, we can help autistic children to get a basic understanding of their emotions and how to express them correctly. The model can get the 91% of accuracy for emotion recognition. When we consider the CNN model for the classification the accuracy of the classification is not efficient and for the RAVDESS data set it gets decreased which is not efficient. But this model should train using more data to identify some other emotions and to optimize the performance of the model.

6. Future Works

As for the future works, we hoped to get the real-time recording of the child and then identifying articulation

disorder like blabbering, neologism, and echolalia of it by CNN based model and then developed a speech recognition bases therapy system to give speech therapy to according to the level of the autism, to overcome these disorders.

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Designing of a Web App for Hiring Vehicles and Purchasing Travelling Items using Kansei Engineering

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Abstract: *In web design, user interface design is crucial. Designing a user interface that meets the emotional requirements of users is critical since the user interface plays an essential part in creating memorable user experiences for websites. A poorly designed user interface gives a wrong impression on users and decreases their comfortability. It will provide them with opposing ideas and less satisfaction. This must be avoided to get the best results from a user interface design in applications. Kansei Engineering, a well-known technique for designing applications, considers the emotions and feelings of particular users. This study attempts to turn users' feelings and emotions into design aspects using Kansei Engineering technology to develop an appropriate travel website by defining a standard web design that fosters emotional engagement. This study proposes and explains the idea of Kansei Engineering and an overview of a developed travel website using Kansei Engineering, including all critical factors considered while designing and statistical data.*

Keywords: *E-commerce site, Kansei Engineering, Travel*

1. Introduction

People need to travel frequently. Despite the fact that we are social creatures of the same species, where we live has an influence on how society functions. We encounter many cultures when we travel. Traveling takes us out of our comfort zones, which inspires us to see, taste, and attempt new things. It continuously puts to the test our capacity to engage with varied people, embrace new experiences as they arise, and share them with friends and loved ones, in addition to our capacity to adapt to and explore new places.

The people who don't have a mode of transportation or travel will find alternative methods. Most of the people like to travel by comfortable medium of transportation for affordable prices. Traveling companies must provide these requirements according to the customers will. There are various kinds of web pages helping the travellers to hire vehicles and buy the items which needed for travelling. But most of them are not user friendly and some of them are not attractive for customers, in some websites the necessary information regarding vehicles and other items are not mentioned properly. Travel may be addressed in a variety of ways. Students and researchers typically travel in groups or with their families. So the website must clearly contain all the details related to the audience which the design is prepared for. And these websites are oftenly used by tourists. The quantity of tourists arrivals in Sri Lanka increased by 1,917.8 percent year on year to 30,207 in May 2022, as a result of rising vaccination rates around the world and softer restrictions for vaccinated travelers. Largest amount of tourist were arrived from India , accounting for 18.4 percent of total traffic, followed by the United Kingdom (12.3 percent), Russia (10.6 percent), Germany (7.3 percent), and Canada (6.7 percent). Visitors from Europe accounted for 48.8 percent of overall arrivals in Sri Lanka in May, while those from Asia Pacific accounted for 33.3 percent. Monthly visitor arrivals fell by about 52 percent as a result of the consequences of Sri Lanka's present economic and political circumstances, as well as the gradual end of the peak season.

In theory, both user happiness and technological elements are necessary for good design. Understanding and satisfying people's demands is thus one of the most important components of design.Therefore to attract the tourists and travellers in to this kind of web design, the design must be unique and eye catching as well user friendly.Web sites that bring positive emotions to users must meet all three levels like pleasure, usability and functionality(JORDAN'S HIERARCHY OF NEEDS (Jordan, 2000)). The designed web page is for hiring vehicles and needful items for travelling. Using Kansei Engineering this project was focused on the design of the interface of a particular webpage. Phycological factors which describes about the colours, images of the designing were considered.The hiring of the website which is designed here won't supply for permanent travelling.

The term "Kansei" originates in Japanese and has no exact English equivalent. Kansei is defined by Nagamachi as "an individual's subjective sensation from a certain artifact, place, or scenario employing all of the senses of sight, hearing, feeling, smell, taste, and recognition" (Nagamachi, 2001). Kansei Technical Engineering, as the name implies, refers to technology that merges Kansei with engineering domains in order to penetrate people's Kansei into product

design so that the goods can elicit emotional reactions and please consumers (Lokman et al,2009).

Kansei, which varies from person to person and is impacted by people's experience, knowledge, personality, and mood, is too implicit to be assessed directly. Some standard measuring methods based on externalisation have been developed and effectively used in specific domains.

Given the significance and potential of embedding emotions into web site design, as well as the possibility of using Kansei Engineering as a requirement generation technique to improve user experience, this travel website will be very appealing to both tourists and locals in terms of purchasing goods and hiring vehicles.

2. Related Works

Brief description of some travel websites is given below:

A. VacationSpider.com

VacationSpider.com is a website gives the facilities with discount hotel prices from all around the web, making your search for low price travel easy and convenient, great selection of hotels to choose, a luxury hotel or something more budget-friendly in New York or in Las Vegas.

B. Booking.com

Booking.com is a travel website which provides the facilities of booking accommodation places, select flights, cars for hire, attractin places and details on airport taxi services for many countries including Sri Lanka.

C. Expedia.com

Expedia is an online travel website and hotel booking services which has connections with many popular sites of Hotels. It is clean and straightforward with the user interface. Trvelars can add up to five connecting flights, choose to add accommodation for all of their trip, and tag on car rentals too.

D. CheapTickets.com

CheapTickets is a website does things a little differently than Expedia. Travelers can easily add on flight, hotel, and car or any combination of the three for package deals, although multiple flights are under a different option. You can also purchase event tickets from this site.

E. Priceline.com

Priceline is a big deal in the online travel website all over the world. It has the facility of effortless to use with options available for flights, cars, hotels, or any combination. But with this you will not get an incredible bargain if you booked separately.

3. Methodology

This product's methodology is mainly based on Kansei Engineering. Kansei Engineering parametrically connects a

product's or service's features and attributes to the emotional reactions (both physical and psychological) of the consumer. Products can therefore be created to express the desired feeling.

Following figure 1 describes the working principle of Kansei Engineering.
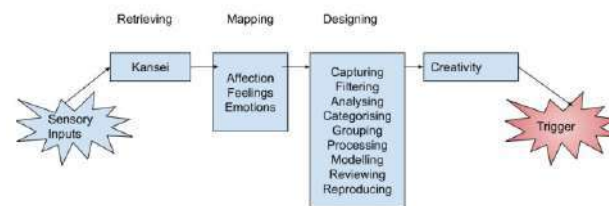

Figure 1. Working principle of Kansei Engineering

Kansei Engineering methodology is started by choosing a domain. Typically, the product is used to pre-select the domain and the target audiences. The choice of a target market segment, as well as the specification of the new product, are all included in choosing the domain. Product examples are gathered to represent the domain based on this data. Then the domain is divided into two sections as in the figure as you move downward:

A. Span the semantic

Kansei Words are gathered using the intended domain as a starting point. The words are then condensed in a subsequent phase to a manageable amount. This is possible utilizing the various tools listed below. The data is compiled uniformly in the last section to make the synthesis process easier to complete. Important Kansei Words can be missed in this phase, which might render the outcome essentially useless. Therefore, it is preferable to choose a few more words than is required.

B. Span the space of properties

Before the data is compiled for the upcoming synthesis phase, the task at hand in this stage is to gather all the attributes corresponding to the chosen domain, choose those that appear to have the biggest impact on the user's Kansei, and select products corresponding to the chosen product properties.

Then the space of properties and the semantic space are connected together in the synthesis process as shown in Figure. A variety of product attributes are discovered that have an impact on each Kansei Word.

Moving on, the next step of Kansei methodology is the test of validity. The information acquired may be used to do a factor analysis, and the outcomes can be contrasted with the Kansei words given from the Semantic Space. The amount of output words was intentionally too high. It is now feasible to identify the words that have no impact on the Kansei by

contrasting the results from the first factor analysis (after the selection of Kansei Words) and the second factor analysis (following the completion of the synthesis). If an iteration process is required, this is given back to the semantic space, and only the new terms are utilized.

The data collected from the synthesis can be presented as a model when the validity tests produce a suitable result, as the final step of Kansei Methodology. (Figure 2)
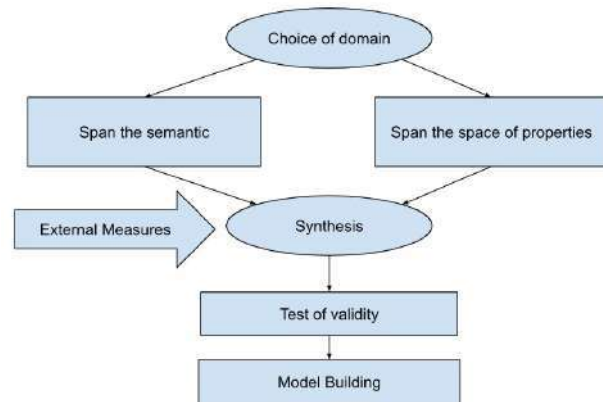

Figure 2. Kansei Methodology

We carried out two studies: one to identify specific design components and the other to assess user's emotional responses to websites for renting cars and other necessary travel necessities. In order to measure the Kansei, we used the Kansei Engineering approach that was discussed in the part before. The Kansei of the visitors and the website samples were then examined to find correlations between Kansei and web design components. The Kansei cluster is then identified by mapping the website samples to the Kansei dataset. (Figure 3)
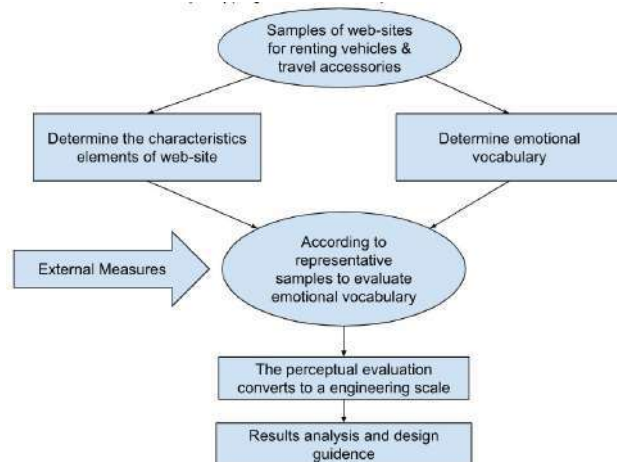

Figure 3. Applying Kansei Methodology for the web-site

4. Results

Using the average evaluation results across subjects, factor analysis and partial least squares analysis were carried out in order to determine the Kansei of the specimen and identify associations between Kansei and design elements.

A. Factor Analysis (FA)

FA is a statistical information minimization technique that reduces the number of unobserved random variables (called factors) needed to explain variation among observed random variables. FA presupposes that a small number of crucial dimensions can be used to summarize all the rating information on various attributes. The relationship between the attributes makes this reduction possible. The influence of other attributes is partially what determines how highly any one attribute is rated.

The psychological structure of the Kansei space is discovered using FA in this study, and the results are detailed on weighted axes. The average value of the evaluation results was used to examine the Kansei space's finer details.

Table 1 displays the factor analysis findings following varimax rotation. The most widely used rotation method that makes it easier to interpret variables is Varimax, which was created by Kaiser (1958). This is so because each original variable tends to be associated with one (or a small number) of factors following a varimax rotation, and each factor only represents a small number of variables. Additionally, the factors are frequently understood by contrasting a small number of variables with positive loadings against a small number of variables with negative loadings.

Table 1. The Table of Contribution and Cumulative contribution

Factors	Variance	Contribution	Cummulative Contribution
1	16.09262	40.23%	40.23%
2	12.29421	30.74%	70.97%
3	3.427578	8.57%	79.54%
4	1.856272	4.64%	84.18%
5	1.810882	4.53%	88.70%
6	0.923415	2.31%	91.01%
7	0.370649	0.93%	91.94%
8	0.250962	0.63%	92.57%

Table 1 depicts that first factor is 40.23% of the total data and the second is 30.74 %. both factors can be taken as the most contributing factors. This table show that the factors provide the highest influence on Kansei Words.

The table below shows results (partial results in ascending order) of FA(Factor Analysis) after doing varimax rotation.

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Table 2: The results of Kansei words, Factor Analysis

Table 3. Design element and Kansei - PLS results

Purple : Highest value   Orange : Lowest

The analysis's findings make reference to the Kansei Words' structure. The table makes it clear that Kansei sample websites are organized according to 5 factors. Professional, cool, gorgeous, impressive, surreal, sophisticated, opulent, masculine, futuristic, and mystic make up the first factor. One way to describe this Kansei space is as "sophisticated." Elegant, endearing, endearing, sexy, cute, beautiful, chic, and feminine make up the second factor. This Kansei area can be characterized as "elegant beauty." The third factor can be described as "simplicity" Kansei space because it is composed of nothing more complicated than that. The fourth factor is light, which can be interpreted as the "richness" of Kansei space. The fifth factor, which can be characterized as "comfy" Kansei space, consists of natural and orderly elements.

According to the outcome it is clear that, the samples of the website are organized according to elegant beauty, simplicity, richness, comfort and sophistication.

The first, second, and third factors identified by factor analysis—sophisticated, elegant-beautiful, and simplicity—explain 79.54 percent of the data. Thus, for the Kansei space, the first three factors are essential. It implies that in order to increase their commercial appeal, these three elements ought to be present on every website. The fourth and fifth factors, wealth and comfort, both matter but have little influence. Because of this, it is suggested that these two components be used as background or supporting components in good website design.

B. Partial Least Squares (PLS) Analysis
A technique for building predictive models when there are several, factors that are highly collinear and have interactions which are significant between x variables can be known as PLS. Partially obtained PLS analysis results are described below.

For each Kansei, Table 4 displays a portion of the results for the chosen "Design Element" whose Range value is greater than its Range. To show the dominating design aspect for each Kansei in order of highest to lowest, the results are sorted in descending order.

Table 4. Each Kansei with its dominant design element

Kansei Infl. No	Adorable		Appealing		Beautiful		Boring	
	Design Element	Range	Design Element	Range	Design Element	Range	Design Element	Range
1	Page Color	0.11488	Header Bg Color	0.14714	Picture Existence	0.0966	Picture Existence	0.12338
2	Product Disp. Style	0.10644	Face Expression	0.14382	Header Bg Color	0.08531	Ftr Menu Font Clr	0.12216
3	Hdr Menu Bg Clr	0.10632	Hdr Menu Bg Clr	0.132	Page Color	0.08049	Product view angle	0.12077
4	Lft Menu Font Clr	0.1087	Product Display Style	0.12532	Left Menu Link St	0.07868	Header Bg Color	0.10646
5	Header Bg Color	0.10218	Body Bg Color	0.12061	Main Font Size	0.0778	Page Color	0.10574
6	Face Expression	0.10024	Page Color	0.11534	Main Font Style	0.07207	Left Menu Font Clr	0.10092
7	Body Bg Color	0.10015	Left Menu Font Color	0.11351	Product view angle	0.06714	Product Display Style	0.10085
8	Dominant Item	0.0998	Picture Style	0.10189	Product Display St	0.06624	Picture Style	0.09771
9	Header Font Size	0.09651	Page Orientation	0.09507	Body Bg Color	0.06569	Top Menu Bg Color	0.09182
10	Main Txt Existence	0.08813	Dominant Item	0.0998	Page Menu Shape	0.06454	Main Text Existence	0.09141
11	Main Bg Color	0.08587	Main Text Existence	0.09253	Ftr Menu Font Clr	0.06441	Main Font Style	0.08811
12	Main Font Style	0.08582	Main Font Size	0.09126	Lft Menu Font Clr	0.06422	Dominant Item	0.08597
13	Main Font Size	0.08324	Header Font Size	0.08926	Page Orientation	0.06276	Empty Space?	0.08459
14	Right Menu Link St	0.07868	Logo Location	0.08588	Picture Dimension	0.05774	Main Font Size	0.08352
15	Picture Arrangement	0.07865	Picture Existence	0.08456	Dominant Item	0.05634	Face Expression	0.08208
16	Picture Existence	0.07838	Main Bg Color	0.08322	Body Representation	0.05582	Main Bg Color	0.08194
17	Page Style	0.07782	Main Font Style	0.08036	Face Impression	0.05531	Hdr Menu Bg Clr	0.08092
18	Picture Style	0.07776	Main Font Color	0.07793	Main Text Alignment	0.05309	Page Style	0.07968
19	Page Orientation	0.07705	Footer Menu Bg Clr	0.07705	Main Bg Color	0.0526	Page Orientation	0.07952
20	Picture Focus	0.07658	Picture Arrangement	0.0753	Page Style	0.04929	Left Menu Link St	0.07785

C. Design Guideline
Under FA, the first 3 factors significantly influence the overall score depicts the whole set of variables. The study has also recommended including the next two elements as supporting features, despite the weak influence. Consequently, a total of five factors were chosen to be a part of the design guideline development. The factors that are involved are the Kansei's professionalism, coolness, attractiveness, impressiveness, surrealism, sophistication,

luxury, masculinity, futurism, mysticism, elegance, adorableness, charm, sexiness, cuteness, beauty, chicness, femininity, plainness, simplicity, lightness, naturalness, and neatness. As a result, the Kansei and identified design elements from the PLS analysis can be used as a guide when developing the emotional interface of an e-commerce website. The outcomes of the constructed guideline are displayed in part in the following table.

Table 5. Results of the constructed Guidelines

Kansei	Design element							
	Background Color of the body	Style of the Body	Page Style	Orientation of Page	Dominant Item	Color of the Page	Size of the page	Logo Existence
Adorable	Sandstorm	Texture	None	Plain	Picture	Sandstorm	Small	No
Beautiful	Yellow	Color tone	Frame	V. Split	Picture	dark cyan	Small	No
Charming	White	Color tone	None	V. Split	Picture	White	Small	No
Light	Black	Texture	Frame	Content	N't	Purple	Small	No
Natural	Purple	Color tone	None	Vertical split	Picture	Black	Small	No
Masculine	Dark cyan	Color tone	None	Header	Picture	Greyish white	Medium	No
Mystic	Sandstorm	Color tone	None	Plain	Picture	Black	Medium	No
Luxury	Dark brown	Color tone	None	Vertical split	Text	Sandstorm	Medium	Yes
Neat	Sandstorm	Color tone	Frame	Footer	Text	Yellow	Small	Yes
Plain	dark cyan	Picture	Table	Content	Text	White	Medium	No
Professional	White	Color tone	None	Vertical split	Picture	Black	Small	No
Sexy	Purple	Color tone	None	Content	Picture	Purple	Small	Yes
Simple	Black	Picture	None	Content	N't	Dark cyan	Medium	No
Sophisticated	Greyish white	Texture	None	Vertical split	Picture	Brown	Small	No
Surreal	Sandstorm	Texture	None	Vertical split	Picture	White	Small	No

D. Construction of Web Interface
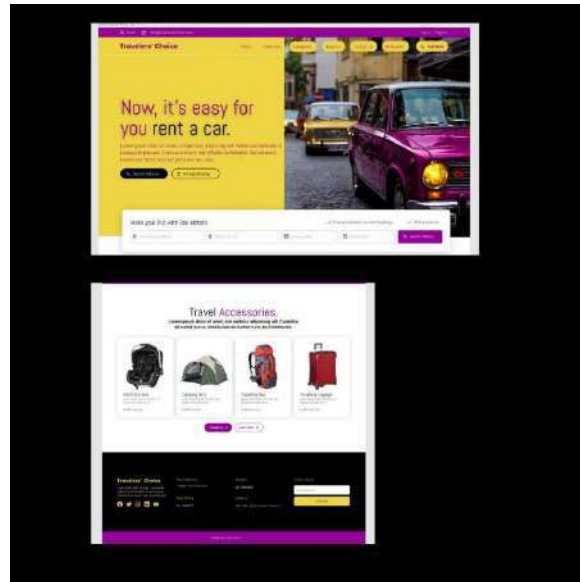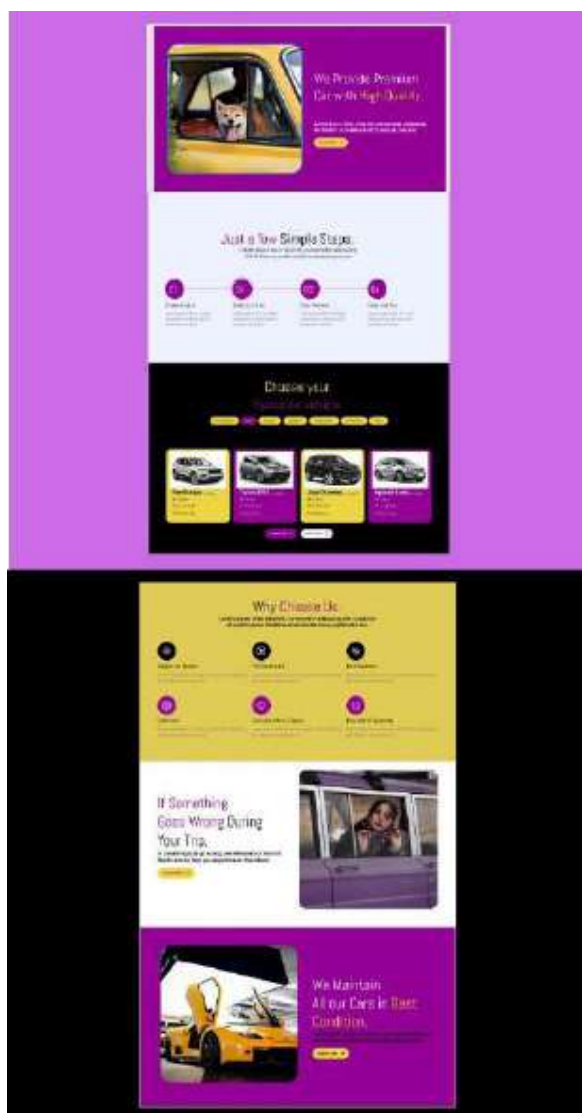
5. Discussion & Conclusion

The process of system design has evolved into Kansei Engineering as a visual support technology for interpreting personal imagery, becoming consumer-oriented, and adapting to the market development requirements of recent years. The purpose is to understand the relationship between emotional responses to visual design and the credibility of a travel website. A visually pleasing website will increase user satisfaction, improve usability and reduce the amount of time users spend searching for information. This study provides the need for an eye-catching travel website through a detailed example. The significance and potential of incorporating emotion into web design, as well as the ability to use Kansei Engineering as a need-generating technology to enhance the user experience, are considered here.

As a result of this research, we have found the following results:

- Among the Kansei words, adorable, appealing, beautiful and boring are used to describe the visual design of the website interface.

- Using a factor analysis, we were able to determine the number of factors and the psychological structure of the Kansei space, as well as the relationship between Kansei responses and the website. According to the results, there are five factors influencing website samples: sophistication, elegant beauty, simplicity, richness, and comfort. It is estimated that this five-factor combination is responsible for 88.70 percent of the data collected. A factor analysis found that the first, second, and third factors are sophisticated, elegant-beautiful, and simplicity, respectively, explaining 79.54 percent of the data.

- PLS analysis Kansei and identified design elements serve as a guide to creating emotional interfaces for e-commerce sites. The sample web site that best suits

Kansei shows the largest positive PLS score for each Kansei respect to each sample web page. However, the website sample that is the most inappropriate to the Kansei has the biggest negative value.

As such, we can conclude that our proposed travel website design method produces Kansei semantic space in the same way as other Kansei Engineering research in other product design fields.

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Abbreviations And Specific Symbols

- FA - Factor Analysis
- PLS - Partial Least Squares

Acknowledgment

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WellnessCare: OCR-based Web Application for Cosmetic Product Safety Assurance

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Abstract*: Cosmetic products are intended to enhance certain aspects that appeal to the aesthetic senses, particularly sight, such as the shape, color, or form of human beings. The global cosmetics market has shown consistent growth throughout time due to the consumers who are mindful of their appearance However, consumers encounter certain issues when using them. As a result of the research study's findings, it is evident that majority of the cosmetic product consumers face difficulties in understanding the meanings of the ingredients also some ingredient names are not correctly included in the product. The popular side effects faced by cosmetic consumers are Skin Rashes, Pimples, Dryness, and Irritation. This study is aimed at developing a web application to ensure the safety of the cosmetics products used by consumers in their day-to-day life. This proposed system will allow the user to assure safety by uploading an image of the ingredient label or by manually typing the lists of ingredients. Here, the subset of the image processing domain, Optical Character Recognition technology is used to extract text from the uploaded image. It will output a report by displaying the descriptions of each ingredient, respective severity scores, and the overall score of the product by mentioning whether it is favorable or harmful to the health. Here the necessary datasets are gathered from a reliable and accurate source. This system will ultimately contribute the economic growth and will increase the sales of products and the safety of the consumers in the beauty industry*

Keywords: *Optical Character Technology, Cosmetic Products, Safety Assurance.*

1. Introduction

The beauty industry is truly remarkable and its rapid expansion is almost recession-proof. The main reason is that it does not only sell products but also sell hope, aspiration, passion, and dreams with it. Today, the beauty industry has returned to its roots, with science-based products doing double and triple duty (Avenue Five Institute,2021). If a product is designed to make someone more appealing, cleanse the body, or otherwise alter someone's look, it is considered a cosmetic. Cosmetics are items created to beautify, protect, and change the appearance of our bodies' external features. Cosmetics were not introduced today. For at least 10,000 years, and possibly much older, people have utilized various substances to change their look or attract attention to certain features (Chemistry of Cosmetics,2022). Cosmetics are a necessary part of our daily lives, including antiperspirants, scents, make-up, shampoo, soap, sunscreen, and toothpaste. Cosmetics are heavily regulated to ensure their safety, primarily under the EU Cosmetics Regulation. Every cosmetic and personal care item available on the European market is risk-free to use (Cosmetics Europe, 2022).

Even though the beauty care industry has expanded to a wide range of products, there is a critical concern about the safety of these products. The European Commission has launched a public consultation on the upcoming targeted revision of the EU rules on cosmetic products. It requests input from all interested parties on how to further enhance current regulations about the security of various hazardous compounds and their exceptional and rigorous use in cosmetics. New standards for reporting product safety are introduced by a new cosmetics rule. Nanomaterial-containing products, such as UV filters and colorants, must have formal authorization (European Commission,2022).

Consumers of these beauty products, both men and women, value transparency and are concerned about the safety of the goods they use in their regular lifestyle. The majority of consumers are unaware of the ingredients available in the products used in everyday life, and some of the ingredient names are even hard to pronounce. Customers should make an effort to get trustworthy brands from well-known retailers. Cheap imports or internet purchases of copies could not have gone through the required testing and evaluation procedures. The names of the ingredients listed on a product's ingredient list can greatly aid consumers in making wise decisions. In addition, it should be the responsibility of the consumer to ensure that the products are safe and labeled correctly. As a result, the main research problem addressed here is to identify a method to validate the safety and quality of cosmetic product categories.

The main objective of this study is to develop an interactive software system that can be used to verify the safety of all cosmetic categories.

2. Main Objectives

1. To examine the challenges the consumers, encounter when examining the ingredient lists on cosmetic products.
2. To investigate the negative consequences that cosmetic consumers have experienced while using cosmetic products.
3. Develop an interactive web application to assure the safety of cosmetic products using Cosmetic Ingredient label Analysis via Optical Character Recognition Technology

3. Related Works

This study has found out that "Cosmetic Ingredient Review" is an independent, scientific review board that critically evaluates ingredients used in cosmetics. The FDA has regulatory oversight and the CIR should be encouraged to

publish its findings. "It is the dose that makes the poison," Paracelsus said in the 16th century. The American Council on Science and Health has reviewed claims that cosmetic products are not regulated adequately. The ACSH's review included an examination of industry practices and stewardship related to safety testing and evaluation of ingredients. It also looked at regulation by the Federal government and the history of use and testing of some specific cosmetic ingredients (Ross,2006).

This study has discovered the ingredients that possess health effects that can be found in cosmetics and personal care products. Preservatives, fragrances, and heavy metal impurities were reviewed. Many chemicals remained arguable in terms of safety and their presence in the products (Zulaikha et al.,2015).

According to this research, the Cosmetic industry is considered one of the most rapidly growing sectors both in Poland and across the world. Plant-based raw materials have rich chemical compositions, which makes them appropriate for a variety of applications. They are suitable for consumers of different ages and with various skin types, and for the treatment of dermatological diseases. Fructans, including inulin, have also found cosmetic applications in hair shampoo production. Inulin is used as a stabilizer in cosmetic emulsions and detergents. It is suitable as a base for powders and sprinkles and as a nutritious ingredient in cosmetics (Łukaszewska et al.,2019).

This study has found that Allergic Contact Dermatitis (ACD) is an increasing problem in children. This study has found that 88% of products had at least one reference contact allergen. The most abundant compounds were parabens, fragrances, cetyl/stearyl alcohol, and methylisothiazolinone (Low et al.,2018).

The researcher discovered that cosmetics is a source of lifetime exposure to various substances including para-bens, being the most popular synthetic preservatives. Special attention has been paid to absorption. Parabens and their retention in the human body in the intact form, as well as their toxicological characteristics. Particular emphasis has been placed on the estrogenic potential of parabens (Matwiejczuk et al,2019).

This study has found that cosmetic products contain a wide range of chemicals to which we are exposed every day. Fragrances were present in 52.3% of the examined products, mostly limonene (76.9%) and linalool (64.6%) but also citronellol (34.1%) and geraniol (31.5%), coumarin (30%) and hexyl cinnamal (29.2%). The most frequently identified preservatives were phenoxyethanol (48.7%) and sodium benzoate (35.6%) (Panico et al.,2019).

The output shown demonstrates the utility of the model in determining systemic and dermal exposure to fragrances from individual products and aggregate exposure. Data on the concentrations of PEA in products used in this article were obtained from limited sources and not standard, industry-wide surveys typically employed by the fragrance industry (Safforn et al.,2016).

Table 1-Comparison of existing web applications

Name	Existing System Features
Cosmetics.lk	• E-Commerce Website • Buys and sells all categories of Cosmetic Products
British Cosmetics	• E-Commerce Website • Buys and sells all categories of Cosmetic Products • Provide Salon and Nail Art Services
INCI DECODER	• Decodes all ingredients • Ability to Compare Products • Ability to view a photo of the ingredient lists labeled on the Product
Skin Carisma	• Allows to browse for Products by category and popular ingredients • Browse Brands • Compare Products • Does the ingredient analyzer process through text analysis
SkinSort	• Ingredient Check using Text Analyzer and Image Analyzer • Browse Products • Allows to Create Routines • Ability to Compare Products • Ability to identify Skin Care Dupes
COSMILY	• Ability to Check ingredients using Text Analysis • Compare Products • Search for Brands
Spehora	• E-Commerce Website • Buys and sells all categories of Cosmetic Products
Ultra-Beauty	• E-Commerce Website • Buys and sells all categories of Cosmetic Products • Provide Skincare Tips
SEKND	• Ability to Check ingredients using Text Analysis • Skincare Quiz • Routines and Reviews • Best Ranking Product Recommendation

Project Novelty

This suggested web application would be more efficient and effective when users of cosmetic products seek Skin Care and Hair Care Solutions for the challenges they are experiencing. It offers an alternative solution using Chat Bot. Through this system-enabled chatbot, system users can raise skin care and hair care concerns and get solutions.

4. Methodology

An OCR-based web application dedicated to cosmetic products purchasing and consuming customers who are interested in knowing the safety of the cosmetic products. As the Research Methodology mixed method is selected as the research choice since the research relies on both quantitative and qualitative data. As per the Techniques and the procedures Interviews, documents, surveys, and content analysis are utilized as the data collection and analysis methods of this research.

According to the current implementations, pre-processing data/images with wordings can increase the accuracy but since there are different types of bottles and textures on the

bottle surfaces, these algorithms struggle to give an accurate result.

Therefore, developing the system by building a machine learning model from scratch will need a lot of data points which are images. Therefore, in this, the most typical strategy is to collect data on all ingredients under each cosmetic product category. Here the necessary dataset is gathered from the "Campaign for Safe Cosmetics" which is a reliable and accurate website (Campaign for Safe Cosmetics,2011) by considering the side effects and harmful effects related to that particular ingredient a severity score is assigned.

The technology used to transform an image of text into a machine-readable text format is known as optical character recognition (OCR). Therefore, OCR Technology is an ideal technology for precisely recognizing text from an image. As the designed system requirement is to compare a given ingredient string against the dataset stored in the database. So, to convert the image data into an application readable format OCR technology should be used.

OCR Technology is used for the ingredient label text detection process. In this OCR flow, the image is first preprocessed so that the data is normalized. First, the raw image with RGB channels is narrowed down to black and white. This will help the OCR algorithm to determine the output within a shorter time while preserving all data points. Then the contrast of the grayscale image is finetuned to pop out the characters. The output from the OCR can have results that have few characters. If a low-quality image is provided the detected characters can include a dot, comma, or a single letter. The Outputs of these results are given out by checking the character length.

This application has a separate configuration and allows all results or limits to have results with lengths with like 3 or more characters. After this, the comparison of these detected results with the existing list of ingredients (with severities) in the database is been done. If there is a valid ingredient, then it selects its severity amount and finally, the system will calculate the average severity for all the ingredient

5. Analysis

A questionnaire was distributed among both men and women who use cosmetics to see if they are concerned about

the safety of the goods they use regularly. It was distributed among 200 people and received up to 145 responses. Out of all the respondents, 91.9% are interested in knowing the safety of the products they use and buy daily.
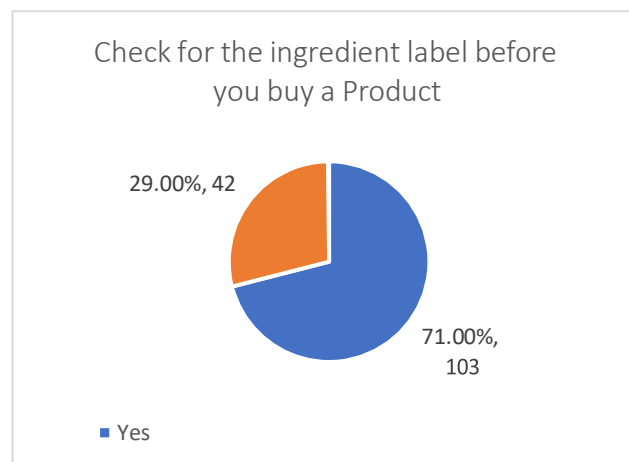
Figure2-Ingredient checking before buying a product

71% of cosmetic product consumers check for the ingredient label before they buy a product.

Figure 3-Difficulties faced when ingredient label checking

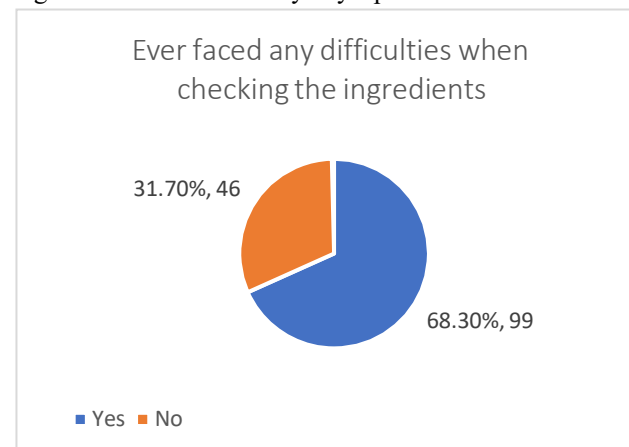That assures that they are concerned about the safety of the products even though most consumers check for the ingredient label before they buy a product out of all the respondents 68.3% face difficulties in checking the ingredients
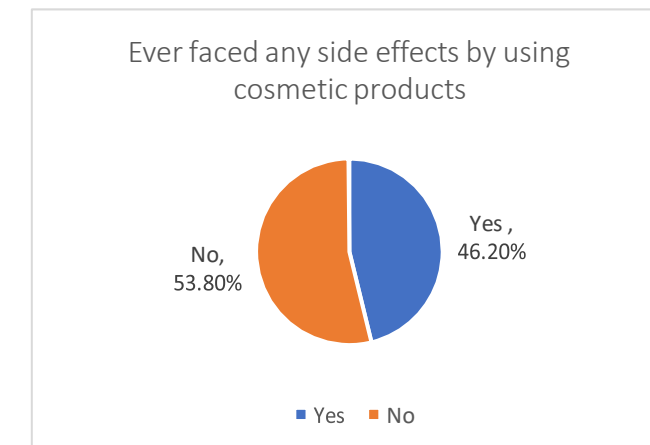

Figure 1-Interest in knowing the safety

Figure 4-Regarding Side effects due to usage

It's visible that there is quite a high percentage of consumers who have faced side effects.so therefore this proposed system will be very useful to check the safety

6. Design & Implementation

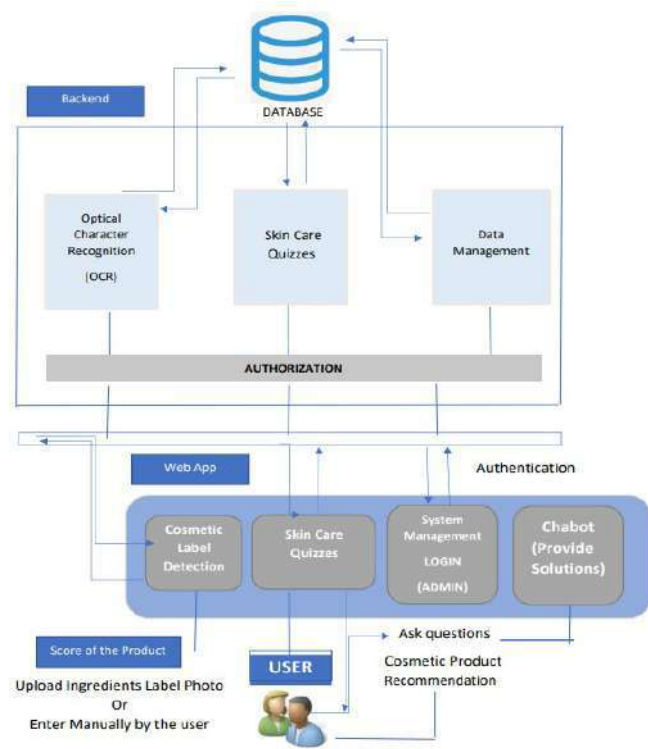The above shown conceptual design of the system which depicts all the functions,

Figure 5-Conceptual Diagram

The potential beneficiaries of this system are cosmetic consumers (both men and women), beauticians, mothers (breastfeeding mothers and pregnant Mothers), baby parents or guardians, and dermatologists.
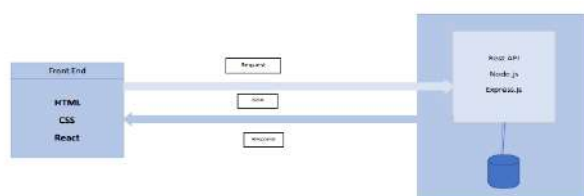
Figure 6- Overall System Architecture

HTML, CSS, and React.js were used in the front-end development of this system, and Node.js was used for the back-end development. Mongo dB is used for the database of the system and the open-source library Tessaract.js is used for text detection using OCR technology.

The functionalities of this system are,

A. Safety Assurance Process

This system provides the user the option of using either the Image Analysis Method, which requires the user to upload a photo of the cosmetic ingredient label, or the Text Analysis Method, which requires the user to input or copy and paste the ingredient lists into the system. The OCR Technology is used for the ingredient label text detection process. The output from the OCR can have results that have few characters. If there is a valid ingredient, then it selects its severity amount and finally, the system will calculate the average severity for all the ingredients. The system detects whether the product is harmful or favorable by mentioning the severity score of each ingredient with a description total score
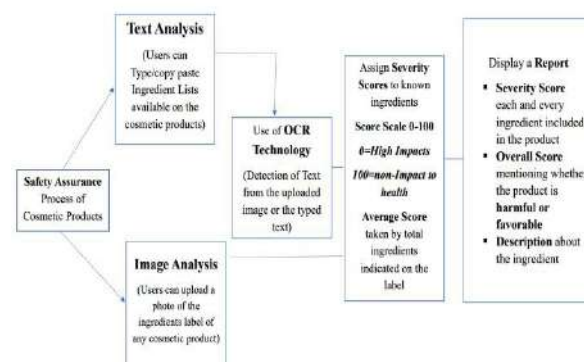
Figure 7-Main Process of the System
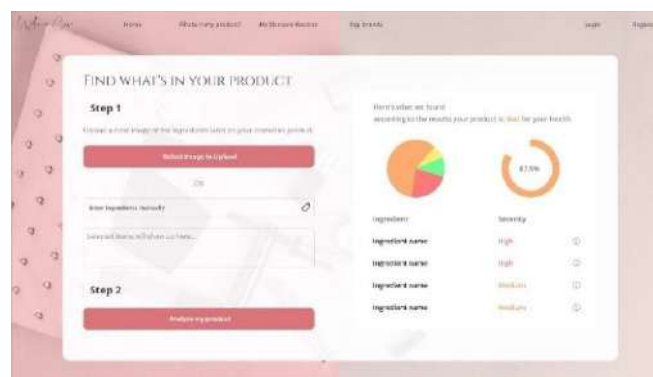
Figure 8- depicts a prototype of the Report

B. Brand Quality Recommendation

The system admin has the authority of adding high-quality cosmetic brands to the system with a brand logo and a description. The necessary data for this was gathered through the survey distributed among cosmetic consumers. The System allows the users to rate that product and provide necessary feedback on that product if they have used it before.
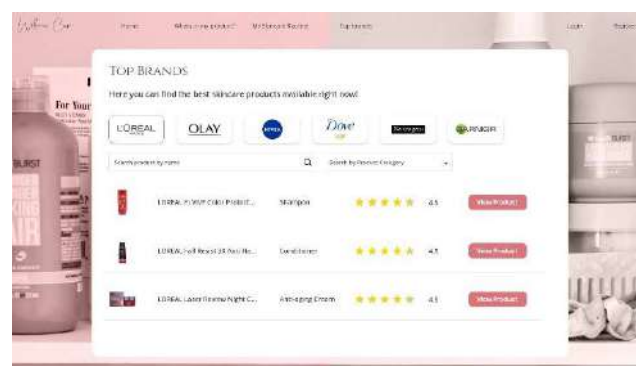
Figure 9-depicts a prototype of the top products

C. Skin Care Routine Creation

Cosmetic consumers who are willing to create their skincare routine can answer the quiz questions concerning answers given by the user a suitable skincare routine will be generated through the system and sent to the user's email
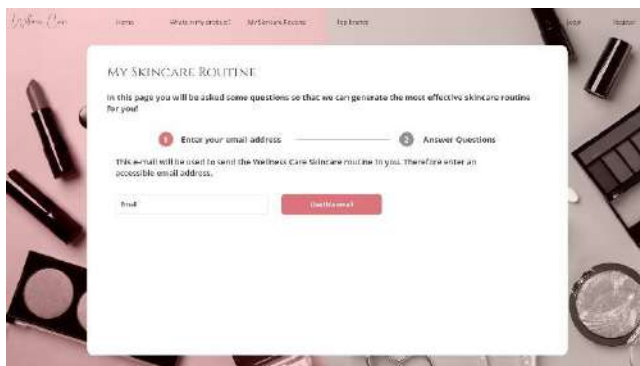
Figure 10 -depicts a prototype of the Skincare routine creation

D. Chat Bot for Skin Care and Hair Care Solutions

Users can ask questions about their skin Care and Hair Care problems and receive solutions through the Chat Bot.
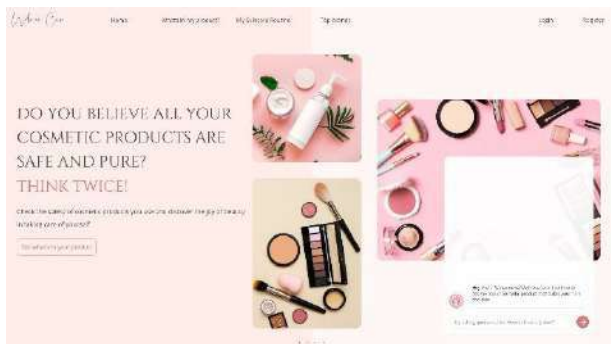
Figure 11-depicts a prototype of the Chat Bot

E. Sun Care Guidelines

The system will provide the users with a Sun Care Guideline which is very informative. It provides

- What is the time to apply?
- How often it should be applied?
- When should you reapply?
- How to apply Sunscreen
- What to look for when you buy sunscreen?

The below figure depicts the Data flow diagram of the Wellness care Web Application.
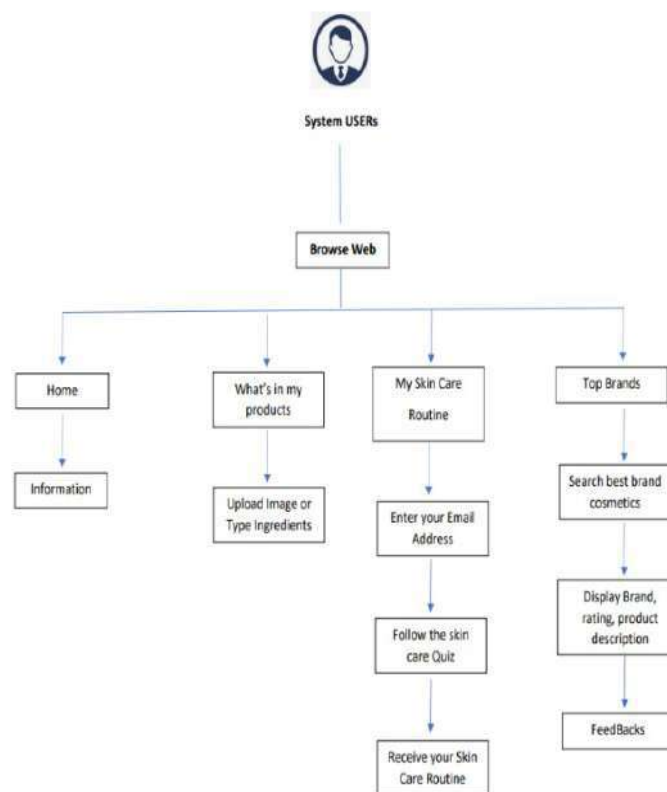
Figure 12-Data Flow Diagram

This proposed web application is designed and developed in a responsive manner which allows the user to access it whenever required by browser or on a mobile phone.

7. Results and Discussion

Table 2- Problems faced when checking the ingredients of a Certain Product

Problems faced when checking the ingredients of a Certain Product		
Problems	Respondents	Percentage
Difficulty in pronouncing the ingredient Names	40	28%
Cannot understand the meaning of the Names	80	55.9%
The font sizes of the ingredients are too small enough to read	50	35%
Not properly mentioned in the product	73	51%
Not at all displayed on the product	55	38.5%
No Problems	4	2.8%

As a result of the research study's findings, it is evident that majority of the cosmetic product consumers face difficulties in understanding the meanings of the ingredients. The other issue is that ingredient names are not correctly included in the product.

Table 3- Side Effects faced by Cosmetic Product Consumers

Side Effects faced by Cosmetic Product Consumers		
Problems	**Respondents**	**Percentage**
Skin Rashes	39	27.9%
Pimples	69	49.3%
Dark Complexion on the Skin	21	15%
Dryness and Irritation	34	24.3%
Skin Color Changes	20	14.3%
Redness	18	12.9%
Swelling	7	5%
Crusting	8	5.7%
Blistering	9	6.4%
Chapped Lips	9	6.4%
No Side Effects	49	35%

As shown in the above table popular side effects faced by consumers are Skin Rashes, Pimples, Dryness, and Irritation.

Therefore, it is clear that the suggested solution will promote the beauty industry's sales by offering a safe consumable goods, which will ultimately help to strengthen the economy.

This application is expected to expand in popularity as the world pursues the trend of using organic, non-toxic items. Due to this new application, people are prevented from using harmful products.

8. Conclusion & Future Work

This paper elaborates on a solution that can bridge the problems which the current cosmetic consumers are facing today. The system allows the users to check and verify the safety of the products they use in their daily life.

As for further improvements, this system can be presented to intended users, such as common consumers men and women, breastfeeding mothers, pregnant women, and baby guardians' dermatologists, and obtain feedback. Based on the feedback obtained, the system can be further developed to make it more effective for each pertaining user.

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Figure 10-Prototype design for the Chatbot

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Development of a Smart Ring Series using Kansei Engineering

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Abstract: People have become more flexible and healthier by using these smart devices to track and do their daily work. Exercises and daily activity management are key factors in a human's daily life. After analysing humans' issues and difficulties, the authors decided to develop an automated device. The researchers aim to develop a smart ring series with different features embedded in them to make the life of humans easy. Some people do not like to wear watches. However, almost all humans, especially females, love to wear rings. So, the authors decided that a ring would be more efficient and user-friendly. After the study, the authors decided to design a ring series as it would be easy for users. They can choose the ring with the feature they need rather than buying all the rings. The authors designed four rings. The first ring is capable of tracking your fitness level. The other ring can be used to lock and unlock your belongings. The third ring can be used to track your emotions, while the last ring is capable of tracking motion. Each ring has a particular feature along with the relevant sensors needed to accomplish the task. The authors have conducted a survey to find the relevant features and have followed Kansei Engineering concepts when designing the final design. The authors have designed the final design by conducting a statistical analysis of the results.

Keywords: Smart Ring Series, Kansei Engineering, Ring, Sensors

1. Introduction

With the increase in the usage of mobile devices in the past two years, people have also shown higher interest in using smart devices to make their work easier. With the development of technology, people use various smart devices to make their daily activities easily. The smart ring is a very unique and small device that can be used at any time without any hazel. If users use a smart ring, it can also be used as a fashion accessory. Also, by the initial studies, authors have recognized that it will be more useful if the authors develop a series of rings, each with one feature, because it will help the user accomplish the dedicated task quickly and efficiently.

In the past, humans used small reminders to track and ensure they don't miss any of the work they were supposed to complete. Also, they had no method of finding out about their physical fitness level or other health factors. With the improvement of technology and smart devices, users can easily use them to accomplish these activities. Also, since the authors are developing a series of smart rings, each with a dedicated activity, the user can decide what features they need and buy the relevant ring.

In the early days, people used different manual locking systems to keep the doors and windows locked. Some of the mechanisms use keys to lock them, padlocks, wood locks, and many other mechanisms. Also, humans in the past did not have any way to check their pressure, blood oxygen, and other physical monitoring. The only way for them to do a health checkup is by either going to a government hospital and waiting in queues and getting it done or getting it from a private hospital. Also, they did not have any mechanism to track their motions like sleeping, walking or sitting. Tracking relevant motions will help an individual maintain a correct posture. The other most important factor is the detection of emotions. There was no mechanism in the past to detect emotions and provide solutions. Early detection of emotions will help to find out physiological diseases in humans.

When considering the drawbacks and loopholes in the traditional system, the authors designed a series of rings which will be able to accomplish several tasks that are important for humans. The authors have selected four features in our ring series with in-depth studies and analysis. They can be stated as; Heart Rate, Blood Oxygen Tracking, Temperature and tracking the calories burned, Unlock the smartphone or tablet and also lock and unlocking doors, Tracking emotions and feelings specially the stress level and Tracking movements such as sleeping, walking and sitting.

The Kansei Engineering method was used for this project. Authors have applied the Kansei Engineering procedure as follows; Drawing images of the proposed Smart Ring System, Evaluating the designs with respect to the Kansei Engineering method, Performing statistical analysis of the evaluated data, With according to the results obtained through analysis, and manufacturing the basic model of the series, Evaluated the product by choosing different domains and carried out an analysis upon the evaluated data and The final step is the development of the Smart Ring Series. As mentioned above, the series of rings have been differentiated according to four selected features that appear most important. The research aims to design and develop a series of smart rings with different embedded features.

The paper is structured as the literature review, methodology, results, discussion, conclusion and further work. The literature review will briefly describe the previously designed systems while the methodology will provide how the research was carried out. The results will give a brief description of the outcomes of the survey. The discussion consists of a comparison between the existing systems and the proposed system.

2. Literature Review

The literature review describes the rings and smart systems implemented before. The authors have referred to some of the previously developed rings. They have compared the features of those rings, decided the research gaps, and proposed a suitable ring to be designed.

A. Oura Ring

This is made up of ceramic and tracks the wearer's daily activities. Also, it will monitor your sleeping patterns and give suggestions to manage your activities. (Heli Koskimäki, 2018)

B. Motive Ring

This ring comes in eight different sizes enabling it to fit almost all finger sizes. This ring is waterproof and has a battery capacity lasting about five days. The main purpose of this is to track the physical fitness of the person wearing it. (James W. Navalta, 2020)

C. Ringly

This ring comes in eight different sizes enabling it to fit into almost all finger sizes. This ring is waterproof and has a battery capacity lasting about five days. The main purpose of this is to track the physical fitness of the person wearing it. (Pringle)

D. Go2Sleep

This consists of a three-axis feature in order to detect sleeping patterns as well as the SpO_2 level of the person. This has a unique sleep detection option that keeps track of the turnings and tossing in the sleep. (Milad Asgari Mehrabadi, 2020)

E. ArcX

This ring focuses purely on the user's fitness, and it is friendly with any Operating System along with the iOS. Also, the battery capacity of the ring can last for about five days once given a full charge. (Bianchi & Je, 2017)

F. Movano ring

This is the most recently developed smart ring. It has a bold design, it is not that thick, and also it is very easy while wearing the ring. The main object of this is also to track the physical fitness and the health status of the person. It is capable of tracking blood oxygen level, body temperature, and heart rate and also, like almost all rings, it can also track sleeping patterns and the amount of sleep received by the person wearing it. (Partheniadis & Stavrakis, n.d.)

Table 1 will give a comparison of the features of the existing systems. The feature called 'Fitness Tracker'

consists of many areas such as SpO_2 level, Heart Rate, Blood Pressure and Calories burnt.

Table 1: Comparison of existing systems

Name of the ring	Fitness Tracker	Sleep Tracker	Waterproof	Alerts	Phone calls	Emergency mode
Oura	×	×				
Motiv	×		×			
Ringly				×		
Go2Sleep	×	×				
ArcX	×			×	×	×
Movano	×					

3. Methodology

The Kansei Engineering Methodology was used as the basic design approach for this proposed product. The following are the main phases the team took when doing the statistical analysis for Kansei Engineering. (Nagamachi M, 2008), (Gamage TA et al, 2021)(Kalhari A et al, 2020) Over the past few years, Japan has invented groundbreaking products before any other country. The foundation upon which all of their technology solutions are based on the understanding of the implicit consumer desires, or Kansei Engineering. A variety of instruments or methods from numerous disciplines, including psychology, marketing, and statistics, are utilized to put Kansei Engineering into practice. The foundation of KE investigations is the integration of quantitative and qualitative research techniques. Figure 1 will depict the flow of Kansei Engineering.
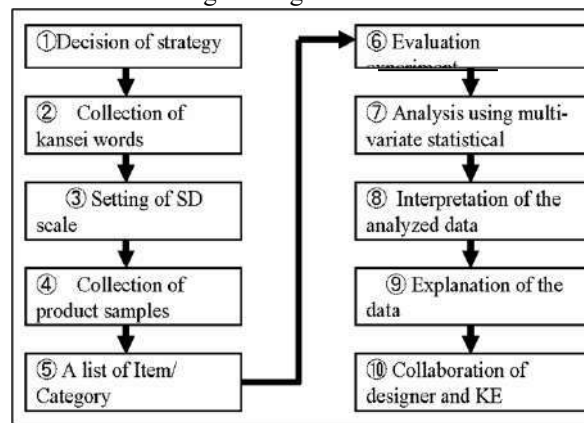
Figure 1 Flow of Kansei Engineering

The steps of Kansei Engineering can be defined as, Collecting Kansei words by studying literature reviews, Creating a survey and a 7-point rating system for the words that were identified, Analysing the Kansei words using a predefined group of individuals, Statistical evaluation of the data gathered, Choosing the features that will best address the words with high ratings, Analysing the outlined features using the defined group of persons, Conduct statistical analysis of the results and Working together with designers to represent the outcomes.

4. Results

Kansei Engineering consists of several steps: the selection of suitable kansei engineering words, the kansei evaluation experiment and the statistical procedure. The

Kansei evaluation consists of the evaluation given for design samples by the participants, while the statistical procedure analyses the relationship between Kansei words and design elements.

A. The Collection of Kansei Words

The 15 terms that have been compiled into a new database for the smart ring series are shown in Table 2.

Table 2: KE Words

User Friendly	Durable	Cheap	Handy	Fashionable
Decent	Efficient	Reliable	Security	Privacy
Comfortable	Reusability		Flexible	Customizable
		Attractive		

It is important to select words that highlight the customer's needs and that will also relate with the product to help us make proposals to satisfy the needs.

B. Weighting

After selecting the words with the highest grades and weights, a separate table with those words was made. Table 3 will provide the corresponding grades and weights of the words. Table 4 will consist of the five words that the team has chosen.

Table 3: Grade and Weighing of KE

Kansei word	Grade	Weight
User Friendly	60	0.50
Durable	110	0.79
Cheap	94	0.67
Handy	80	0.57
Fashionable	88	0.83
Decent	100	0.71
Efficient	99	0.71
Reliable	108	077
Security	105	0.75
Privacy	55	0.39
Comfortable	75	0.54
Reusability	70	0.50
Attractive	67	0.48
Flexible	50	0.36
Customizable	40	0.29

Table 4: Meanings

No	Kansei words	Meaning	Positively correlated to KW	Negatively correlated to KW
Word 1	Durable	Should be able to use for a long period without any damage or failure.	-everlasting -strong -permanent	-synthetic -breakable
Word 2	Decent	Should not consists of various unwanted designs	-Nice -Simple	-Fancy -overattractive
Word 3	comfortable	Should be able to wear it without difficulties	-good -pleasant	uncomfortable -hard
Word 4	Reliable	Results should be accurate and should be in good quality	-accurate -trustworthy	-loophole untrustworthy -uncertain
Word 5	Security	Should protect the data stored in it.	-protection -concealment	-Threats -vulnerabilities

C. Relating Kansei Engineering with Engineering Characteristics

Some characteristics are identified using Kansei Engineering words, and the words and the elements were combined in a questionnaire. Each question consists of a requirement which is related to the KE words. The questionnaire consists of two parts, functional and nonfunctional, to check the requirements of the Smart Ring Series. Table 5 depicts the example of the functional questions. The questionnaire was distributed among 30 participants.

Table 5: Functional requirements in the Questionnaire

Smart ring Series Shape
1). Normal Round Shaped Ring 1- Like. 2- Must be. 3- neutral. 4- Dislike. 2). A square Shaped Ring. 1- Like. 2- Must be. 3- neutral. 4- Dislike. 3). Round Shaped Ring with the Interface in another circle. 1- Like. 2- Must be. 3- neutral. 4-Dislike.
Smart Ring Series Material
4). Gold 1- Like. 2- Must be. 3- neutral. 4-Dislike. 5). Silver 1- Like. 2- Must be. 3- neutral. 4-Dislike. 6). Other (Gold/Silver Plated Brass Ring) 1- Like. 2- Must be. 3- neutral. 4-Dislike.

E. Final Design

After following the procedure mentioned above, the design of the series of rings is as follows. Figure 2 will give the final design. Furthermore, the authors are connecting the ring to the users' mobile phone. The user will also get a notification for their phone regarding the ring's updates.

Figure 2: Final Design

F. Survey Results

The objective of this survey was to find out the targeted group and their preferences. For this survey, the authors have selected a random group of people. About 67 participants have provided their responses in this questionnaire.

If we consider the statistics of the responses received, 61.2% of the respondents were in the 20-24 age group, and 50.7% were males. 83.6% of the population have used such smart devices as smartwatches. Because of that, we can assume they have proper knowledge about smart devices. 52.2% of people choosing Rs. 30,000 – Rs. 40,000/= as the value of the smart ring ensures that they are aware of such devices. The majority prefer decent smart rings. An equal percentage prefer silver and brass with gold plated as the colour.

Considering these facts, if we develop 67 smart rings, X is the percentage value of a specific color, and Y is the total number of responses. The following equation was used to determine the types of rings;

$$\frac{(X)(Y)}{100}$$

Equation: 1

Futher the authors have suggested ten features for the participants of the research. By analysing the responses, they have selected four features and designed four rings. The features were recognized by the types of rings the athours used to analyze in the literature review. When considering the features of the rings, the mostly wanted features were decided. Fifteen smart rings in silver, 15 smart rings in brass with gold plated, 11 smart rings in gold and ten smart rings in brass with silver plated will be sold considering the responses.

5. Discussion

Currently, in the market, there are a variety of smartwatches which can be used to do the same tasks as the smart ring that was proposed, but when analysing deep inside, it is clear that the smart ring has more efficiency, reliability, privacy and is more user-friendly than the smartwatch concept. Though the manufacturing processes of smartwatches and smart rings differ, they use the same sort of sensors. In terms of accuracy, the smart rings are higher than the smartwatches because of their intrinsic form factor design. These sensors perform tasks such as tracking the biometric data, detecting linear acceleration, monitoring rotational movements, and monitoring the user's heart rate. But smartwatches consist of more packed features. The sensors, such as GPS Tracker, are

included in the smartwatches apart from the smart rings. But anyhow, both the smartwatches and smart rings are connected to a mobile app through which the users can log in and collect the relevant data they need. The information gained using the app is always personalized from person to person.

The fingers consist of various arteries and capillaries. These allow smart rings to gather more accurate data than the smartwatches on the wrists. Smartwatches have a greater tendency to expose themselves to natural light and other environmental factors, which can reduce the accuracy of the data. But since smartwatches are placed on the fingers, they are not facing any circumstances like that. Also, the data measured by the smartwatches are considered entirely accurate only if worn tightly on the user's wrist, which is uncomfortable for the user. Smart rings are lightweight and easy to use. So, in terms of comfort, smart rings play a significant role. If the user needs to gather a range of data for a long period, it requires the user to wear the device continuously for a longer period. So, a ring will be the best option to make the user's work easy and comfortable while obtaining accurate results. When considering durability, smartwatches and smart rings do not have much difference. But the strap of the smartwatches wants to last as long as the display, while smart rings would not have such circumstances. Privacy is one of the significant factors that users need to consider when using a wearable smart device that tracks their private details, such as health conditions. So, users must be vigilant that this sensitive data is always under threat. The issue with smartwatches is that they have a display and sometimes speakers that anyone else can view or hear once the user switches on them. But the smart rings usually do not have displays or loudspeakers. But other than that, the privacy factor depends on the user. Since both the smartwatch and smart ring are wearable devices, it is required to consider their battery life. Most fitness and activity smart rings can last for 7 days. But an average smartwatch can only last for 18 hours. It might be because the smartwatches have comparatively bigger screens than smart rings, which consume more battery life. Especially in an era like now, people are very concerned about the pricing of the devices they purchase. The device needs to be worth the price they are paying. Smartwatches indeed consist of comparatively more features than smart rings, but those are more expensive than smart rings. Depending on the model, a quality smartwatch with activity and fitness tracking features costs between $150 and $600.

Regardless of wearable technology, the most widely used brands always have higher prices. In contrast, the price of smart rings in the same market might range from $100 to $300. If you do not need to display the details you need to measure all the time, the best option is to buy a smart ring because that does the same function for a lower amount of money. So, the factors mentioned above make smart rings a superior choice over smartwatches because of their incredible features. The ring design follows the KE concepts to give the users the best experience. The results of this paper's analysis make it abundantly evident that

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analytics information may be used to enhance userfriendliness and customer satisfaction. The main obstacles highlighted by the experts in the sample included a lack of technical professionals, high starting costs, and a lack of technical expertise. However, most respondents thought mobile applications improved the customers' experience.

6. Conclusion

The demonstrated wearable smart ring series can provide accurate and useful data for the users. Wearable technologies have evolved mainly with technological advancements such as Global Positioning Systems, Bluetooth, Wi-Fi, and sensor systems. The author hopes to provide users with a series of smart rings by implementing a smart ring series. The first series shows the fitness level of the user, including temperature, heart rate, oxygen level of blood and calories consumed, while the second series provides features such as unlocking your smartphone and tablet and also closing and unlocking your door. The third series tracks your emotions and stress levels. The fourth series will track movement, which includes walking, running and sleeping. Users of smart rings can customize according to the material, the size of the finger and varied materials available. It will be much helpful to maintain a healthy lifestyle because most people resist doing checkups with their busy lifestyles, so with the smart ring series, maintaining a healthy body has become an easy task for users.

Further, the smart ring is charged using an external port, and the ring is connected to the user's smartphone so that all the notifications and results will be displayed on the screen and can be controlled accordingly. The smart ring series will be helpful in the day-to-day life of a person by making the users lives much easier with its unique features, handy size and user friendliness. Smart rings will have a good market demand in the future with more technological advancements and new features adding up.

A. Future Work

As for further work, the number of features for a ring series will be increased. According to the suggestions received, functions like calling, voice assistance, alerting users when their hands are tired and requesting that they take a break can be included. This will help programmers avoid a repetitive strain injury. Another feature which could be added is to alert people to the power outage time based on where they live so that it would be helpful for them with the current situation in Sri Lanka. Further, planning to make rings with varied materials which are non-rusting, long-lasting and affordable.

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ePharm: A Mobile Pharmacy Application for Locating Nearby Pharmacies

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Abstract: The use of mobile phones and the implementation of mobile applications and services have progressed dramatically in the present society as they have made the lives of people more efficient. Even then, if the prescribed medications are difficult to obtain or unavailable in some pharmacies, patients must visit many different pharmacies to obtain them. This is mainly because there is no proper network between the existing pharmacies. It is hectic task to visit numerous locations merely to find a certain medicine, especially in the current economic crisis in the country with the shortage of medicines and fuel. It would be more efficient and effective, in terms of time and energy, if there was an app that could discover nearby pharmacies where the recommended medications are accessible. A mobile pharmacy application is presented as a solution to the problems that individuals experience daily. The goal of this research is to find the major requirements for implementing the application and designing it by integrating those features. Following a thorough literature analysis, it was able to identify the drawbacks of the existing systems and determine the appropriate technologies for implementing the identified features. Through that Google Maps API and Google Directions API were recognized as adequate for geographical placing and tracking of pharmacies. These technologies would improve the accuracy of the system's ultimate output while also making it more usable for consumers. Further, these outcomes can be used for the future implementation purposes of the mobile pharmacy application.

Keywords: Mobile app, System design, Pharmacy application, Geolocation positioning

1. Introduction

Healthcare is a system that is supported by a variety of disciplines that are critical to its progress. Pharmacy is one of these fields in particular. The root term of Pharmacy is pharma, which refers to the knowledge and technique of drug manufacture and administration ("pharmacy | Britannica," 2017). To be more exact, pharmacy is a clinical health science that combines medical science and chemistry, and it is responsible for the discovery, manufacture, disposal, safe and effective use, and management of prescriptions and pharmaceuticals. It is one of the most important and accessible health professionals to the public, as they are available to provide personalized advice about health and medicine on a walk-in basis, without the need for an appointment

As mentioned above, pharmacy plays an important part in the healthcare system. The purpose of pharmacies is to assist and sustain the healthcare system. Clinical services, medication safety and efficacy reviews, and pharmacological information are all part of the package.

According to the international pharmaceutical federation, sixty-nine countries and territories reported a total number of 1,580,575 community pharmacies (including branches supervised by a pharmacist, but excluding mail-order only pharmacies), serving a population of 5,549 million people which is75% of the world's population. Further there are similar amount of hospital pharmacies and mail-order pharmacies around the world adding the sum of total pharmacies into a larger number.

Similarly, there are a wide number of online stores for the pharmaceutical purposes. But most of these pharmacies are particularly built for a single pharmacy, or for an online platform of an existing physical pharmacy. Even though there are a huge number of pharmacies worldwide as mentioned in the above statistics, there is a lack of network and connection between these pharmacies. Due to that reason, people have faced difficulties in going to several different pharmacies in order to find drugs, especially if they are not available in one particular pharmacy. Further, this is a time-consuming and energy-consuming process where, patients experience significant challenges in locating rare drugs, and they are unable to compare the pricing of the same drug at different pharmacies. This has been a concern for the elderly, who have difficulties in traveling, as well as practically to all persons, especially during this economic situation in the country and the Covid-19 epidemic. This was clearly shown through the results obtained through the survey carried out to identify the research problem, where 71.2% of the people who participated in the survey has faced difficulties in obtaining medicines especially during the pandemic period with quarantine and social distancing regulations.

Hence it is more efficient and useful if there is a proper network between the existing pharmacies, where the patients can search a particular medicine they need and find, locate the nearby pharmacies where the drugs are available. Throughout this study the limitations of the

existing systems are identified, and the proposed system is designed to address those limitation and the user requirements that were identified.

2. Literature Review

In the Sri Lankan context, there are around 5000 pharmacies serving a population of 21 million people (Rannan-Eliya and Sikurajapathy, 2009). Also, there is a number of online platforms developed for the pharmaceutical purpose and the trend of having an online portal for the business purpose has increased vastly(Klaic et al., 2022), especially due to the covid-19 situation. There is a various number of studies and research that were conducted related to this pharmaceutical area as well.

For the review process I identified 08 most common features and functionalities that could be seen in existing applications and reviewed 10 pharmaceutical applications based on those features. Further 07 more applications were reviewed to identify on the tools and technologies to be used for the implementation. Table 1 presents a comprehensive review on existing pharmacy system together with the features and functionalities included in them.

Table 1. Summery on features of the Reviewed existing systems

Application	Upload prescription	Add to cart option	Get delivered	Chat with pharmacists	Provide information about medicines	Channelling doctors or place bookings	Monitor and send alerts for reordering	Manage prescriptions
SwipeRx ("What are the benefits of using SwipeRx?," 2022)					✓			
Healthnet ("Most Trusted Online Pharmacy in Sri Lanka | Healthnet.lk," 2022)	✓		✓	✓			✓	✓
Healthguard ("Best Online Pharmacy in Sri Lanka | Healthguard," 2022)	✓	✓	✓					
Doc990 ("About Us - Doc990," 2016)	✓		✓			✓		
Mymed ("Our Story | MyMed.lk," 2022)	✓		✓	✓				
HealthX ("HealthX - Sri Lanka's one stop app for healthcare services," 2022)	✓					✓		
Quickmed ("Quickmed.LK," 2022)	✓	✓	✓					
Unique Pharmacy ("Products – Unique Pharmacy," 2020)	✓	✓	✓					
Union Chemist ("Upload your Prescription Now – Union Chemists Pharmacy," 2022)	✓	✓	✓					
PharmEasy ("PharmEasy - Healthcare App - Apps on Google Play," 2022)	✓		✓			✓	✓	✓
Netmed ("Netmeds Sign In / Sign Up," 2022)	✓	✓						
Count	10	5	8	2	1	3	2	2
Percentage (%)	90.9	45.4	72.7	18.1	9	27.2	18.1	18.1

According to the table 1 it can be seen that the above-mentioned pharmacy systems are consisted with many

innovative features but, the limitations of these existing systems are, that these systems are designed for a single pharmacy. Through these applications people can order medicines from the particular pharmacy that it is designed for. But the problem is that there is no network between the existing pharmacies.

When creating a network between the pharmacies, it is more beneficial to the users if the application could find and locate pharmacies where the user required medicines are available(Siuly et al., 2021). Therefore, a study was carried out to identify the suitable tools and technologies for this purpose.

For the purpose, of locating a place on a map there have been several technologies used in the reviewed research of different research areas.

CamPharma (Noutat et al., 2016)is one existing system that is quite similar to our proposed system with the ability to locate the pharmacies close to the patients with including other features such as searching pharmacies with a specific drug; view the price, information of it; receiving alerts.

Through the review of research on map-based geolocation displaying systems, useability and user-friendliness (Bevens et al., 2021) were identified as key factor to be considered ("What are the benefits of using SwipeRx?," 2022), (Nurwarsito and Savitri, 2018; Pardo et al., 2010; Sholeh et al., 2017).

In (Pardo et al., 2010), a user-friendly graphical interface was used to easily guide the users to the nearest pharmacy by using geographic and temporal information retrieval methods. Ibrahim and Mohsen (IBRAHIM and MOHSEN, 2014) ensure useability and user-friendliness by allowing the users to add, remove or review locations on the map while providing the basic navigation functionalities as well. For this reliable and open-source tools and technologies like Google Maps API, Google Directions API, MySQL, PHP and JSON had been used. Furthermore, the completeness of the system makes the system more usable and easier for the users to use. Based on that, integrates features like searching information and the location of a place on a map. According to this research ("Smart Geographic object: Toward a new understanding of GIS Technology in Ubiquitous Computing," 2015), languages like PHP, Perl and CGI can be integrated in Google map APIs.

In the mobile application ("What are the benefits of using SwipeRx?," 2022)to automate the posyandu activities map features were integrated to search the locations. For this Google Maps API Geolocation Tagging method, which is a JavaScript-enabled library was used. Apart from the Google Map API and Open Street Map API, a geolocation API was introduced for the orange Emerginov platform (Pinandito et al., 2018) which maintains geolocation data on an offline environment while periodically updating it from an online database.

Manav and Anupam ("Smart Geographic object: Toward a new understanding of GIS Technology in Ubiquitous Computing," 2015) proposed an implementation of a location-based service using Google web services and Walk Score Transit API. In this, longitude-latitude-altitude coordination system, Global Positioning System (GPS), Assisted GPS were identified as the methods for discovering the position of the mobile or users.

3. Methodology

This application is a platform that enables the users to find and locate any nearby pharmacy that has the required drugs available with them. Through this application, the users can also request navigation support to get to any selected pharmacy that they require. The major feature of this is that the ability to access any pharmacy through a single platform.

The following subsections present the steps that were carried out to identify the requirements that should be integrated into the application and determining the design of the application before development.
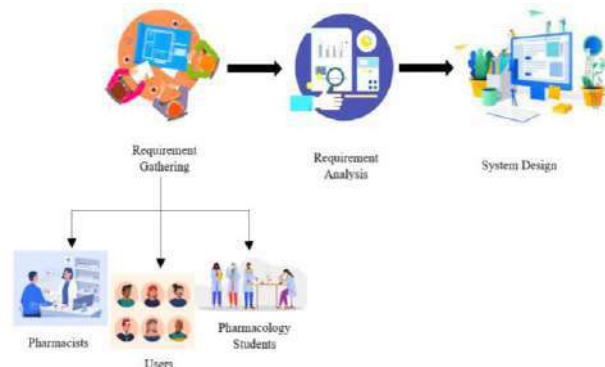

Figure 1. The methodology of the research
Source: Author

A. Requirement Gathering

During the requirement gathering phase, questionnaires were distributed between 52 users representing almost all the age categories, and interviews were carried out with ten pharmacists and then their answers were taken down into a form. These surveys were carried out to gather the requirements that they expect from the application according to their perspective. Another round of requirement gathering was taken place by distributing a survey to 12 pharmacology students to get the requirements and suggestions considering them as individuals who knows the requirements that the system should fulfill for the common users and to the pharmacists in general. Further, during the requirement gathering process the privacy and security ethics were taken into consideration. When dealing with the users' and pharmacology students' opinions their anonymity was protected by not collecting their names, email addresses or any other form of personal identification details. Also, sensitive information like their illnesses the medicines they use were not asked in the survey questionnaires.

In these surveys the users were given a set of features like, including a scanner to identify handwritten prescriptions, locate the pharmacies on a map, a communication platform

to connect with the pharmacists, a description about the medicines displayed on the prescription, ability to compare the prices of different pharmacies. The Figure 2 presents the results obtained from the users regarding their preferences to have the above-mentioned features in the application.

The users have further suggested on having features like, the ability to find similar brands of a certain medicine, index the search to find drugs based on the disease and symptoms and the ability to get alternatives for a given medicine. The users also suggested on integrating a feature where a notification would be sent to the pharmacists when a new order is placed by a user.
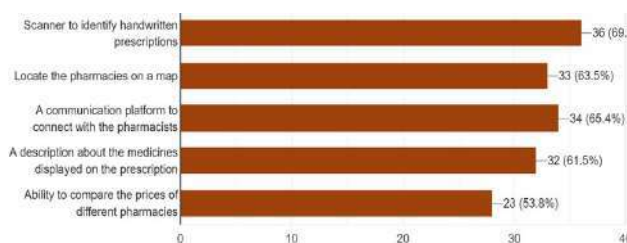

Figure 2. Results of the user preferences on features to integrate in the system
Source: Author

When considering the requirements for the pharmacists' portal in the proposed system, the survey included a set of features and asked for the pharmacists to select the features that they prefer to have in the application. These features are, a chat option to connect with the patients, an option to contact the doctors, ability to add/update details of the pharmacy, send alerts to the system, update stock details, a way to deliver medicines to the patients, ask for prescriptions, symptoms and other details required. Figure 3 presents the results obtained from the interviews conducted with the pharmacists.

Also, the pharmacology students were given the same set of features and asked for their preferences on them about the features and requirements were assessed.
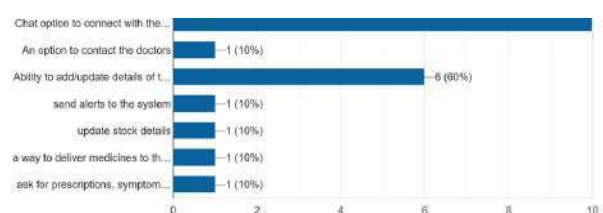

Figure 3. Results of the preferences of the pharmacists on features to integrate in the system
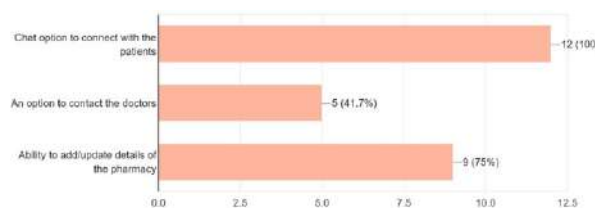Source: Author

Figure 4. Results of the preferences of the pharmacology students on features to integrate according to the pharmacists' perspectives
Source: Author

B. Requirement Analysis

The requirements that are essential for system development are the functional requirements, on which the developing system, should be focusing on. The requirement analysis process was carried out in order to identify the critical functional requirements based on the responses gathered through the interviews and questionnaires distributed in the requirement gathering phase. In here as the analysis method a deductive approach using a Likert scale and based on the responses the hypothesis testing was carried out. Table 2 presents the number of responses received, the scores and thus the criticality of the functionalities classified accordingly.

Table 2. Summary of the requirement analysis

Requirement	Not at all important (1)	Neutral (2)	Slightly important (3)	Fairly important (4)	Very important (5)	Score	Criticality
Scanner to identify handwritten prescriptions	2	3	3	2	2	35	Not feasible
Locate the pharmacies on a map	0	0	0	3	9	57	Most critical
A communication platform to connect with the pharmacists	0	0	1	3	8	55	Most critical
A description about the medicines displayed on the prescription	0	2	3	7	0	41	critical
Ability to compare the prices of different pharmacies	0	2	6	3	1	39	Nice to have
Ability to search a medicine in a search bar and see the availability	0	0	1	2	9	56	Most critical
Ability to create our own list of required medicines	0	0	4	8	0	44	critical
An option to contact the doctor	5	2	4	1	0	25	Nice to have
Ability to find alternatives for a prescribed medicine	0	7	3	2	0	31	Nice to have
Get navigation support to reach the pharmacy	0	0	1	6	5	52	Most critical

According to the requirement analysis performed and presented in table 2 the critical functional requirements were identified as follows. The users could upload the prescriptions to the system, display locations of the pharmacies that has the drugs available with them, provide navigation support, connect pharmacists and patients through a communication platform, ability to search a medicine in a search bar and see the availability, ability to create our own list of required medicines, a description about the medicines displayed on the prescription.

C. Designing the system

To accommodate the features and functionalities that were identified as critical through the requirement analysis phase the designing phase is carried out. In this phase several

design diagrams are created and planned on how the system should be implemented. The process, features and functionalities of the mobile pharmacy app can be seen through the high-level overview of the system which is presented in Figure 5. Then the use case diagram (Figure 6), sequence diagram (Figure 7) and important UI design diagrams (Figure 8) are presented below.
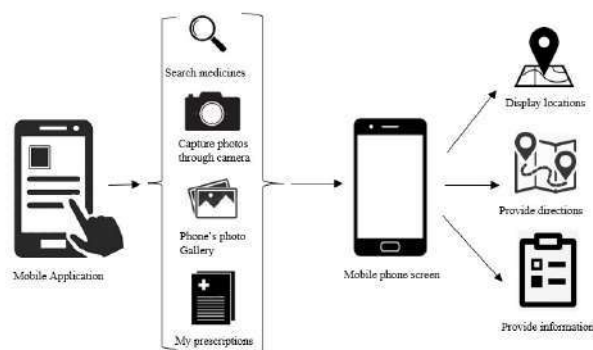

Figure 5. High level overview of the mobile application
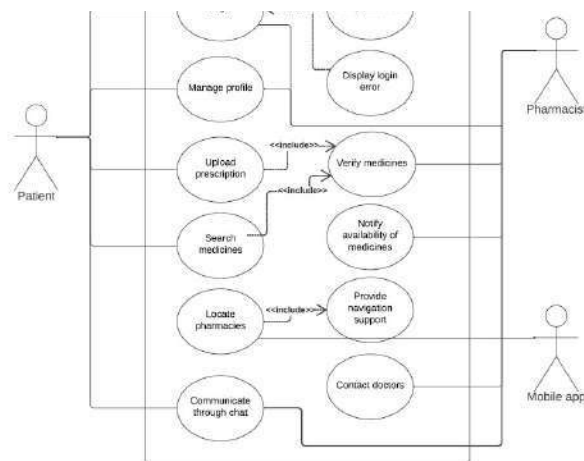Source: Author

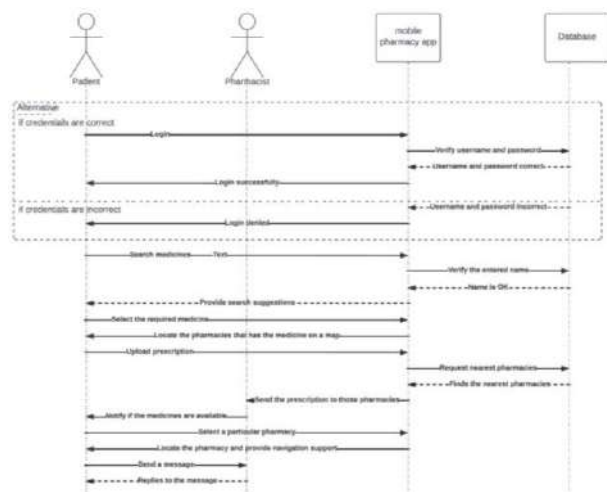Figure 6. Use case diagram of the mobile application
Source: Author

Figure 7. Sequence diagram of the mobile application
Source: Author

Figure 8. UI design diagrams of the mobile application
Source: Author

4. Discussion

The mobile pharmacy application is a very useful and an effective platform, that provides a network between the pharmacies, and it includes functionalities to locate the pharmacies where the particular drugs are available. Since this application's main objective is to make the process of buying medicines easier by saving the time of the users; the usability of the application should be of major concern. Therefore, several surveys were carried out to identify the user requirements for this proposed application.

Even though 69.2% of users that participated for the survey has preferred having a functionality that could scan the handwritten prescription and identify the medicines available there, due to the inconsistency of the doctors handwriting, implementing this feature is infeasible and would lower the accuracy of medicine identification through handwriting recognition. Identifying the doctors' handwritten letters in prescriptions have become a difficulty to the pharmacists sometimes. Through the interviews conducted with the pharmacists it was made clear. And they mentioned some precautions they take to overcome those situations. Therefore, implementing a handwriting recognition model for the purpose of identifying prescribed medicines in handwritten prescriptions was identified as infeasible in this research.
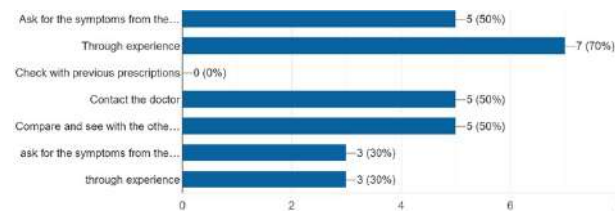

Figure 9. Steps taken by pharmacists to overcome difficulties in identifying medicines in prescriptions
Source: Author

Therefore, as an alternative to that feature, it is proposed to have an option where the patients can directly upload the handwritten prescription to the system, where the system

would identify the nearest pharmacies and forward that prescription to them in order to find availability of prescribed drugs. This prescription uploading feature could be seen in most of the existing pharmacy applications as well, thus it can be stated that it is a more efficient and feasible alternative.

Through the requirement gathering and analysis phase it was able to identify the critical functionalities that the users expect from the system. These include the Ability to upload the prescriptions to the system, display locations of the pharmacies that has the drugs available with them, provide navigation support for the users to get to a particular pharmacy they require, connect pharmacists and patients through a communication platform, ability to search a medicine in a search bar and see the availability, ability to create our own list of required medicines, a description about the medicines displayed on the prescription. These descriptions of medicines are provided to the users through a simple chatbot.

Table 3 illustrates a summary of the analysis regarding the geolocation positioning that was carried out during the literature survey. This was carried out to identify which technologies and tools are suitable for the purpose of locating nearby pharmacies and provide them with navigation and directions support.

Table 3. Analysis performed on tools and technologies for geolocation display and navigation

Application	Google map API	Google Directions API	Custom API	Shortest path algorithm	Swarm intelligence algorithm	GPS
GIRPharma (Pardo et al., 2010)	x	x	√	x	√	x
Online Location based Service (IBRAHIM and MOHSEN, 2014)	√	√	x	x	x	x
Posyandu Administration Services (Nurwarsito and Savitri, 2018)	√	x	x	x	x	x
Web Map based on Scripting Layer for Android (Xing and Lei, 2016)	x	x	x	x	x	√
Geographic Information System (Sholeh et al., 2017)	√	x	x	x	x	x
Location-Based Services in Android ("Smart Geographic object: Toward a new understanding of GIS Technology in Ubiquitous Computing," 2015)	x	x	√	x	x	√
Rapid prototyping (Suddul et al., 2015)	x	x	√	√	x	x
Count	3	1	3	1	1	2
Percentage (%)	42.8	14.2	42.8	14.2	14.2	28.5

According to the reviewed papers, Google Maps API is a vast repository that could be useful to access the Google maps functionalities. Thus, it could be easier and useful for Geolocation display and tracking. Since the system requires real-time results, using a real-time database functionality of Google is much appropriate and easier. Furthermore, since this application is used by ordinary people the interfaces and its operations should be simple in such a way that it could be used by any person without any special technical knowledge and background. The accuracy and reliability of the results and outputs produced by this application should be high. Also, since the application deals with personal details of the users including their illnesses and the medicines that they are using, the security is a key feature that should be highlighted. The system design is carried out by taking all these factors into consideration. And the designs are presented in the previous section.

5. Conclusion

In conclusion, a Mobile Pharmacy is a good answer for the problem identified and mentioned in Section I of this study, especially in this present situation in Sri Lanka with the shortage of medicines and fuel this is a very useful solution. Which allows the patients to easily find a pharmacy where the drug is available. As a result, the user requirements that should be included and the design of the proposed system together with the tools and technologies that are being used were explored in this paper.

6. Future Work

Based on the outcomes and the design created through this research, a more accurate, user-friendly, and efficient mobile pharmacy application is to be constructed as future work. Anyone interested in this topic can use the technologies and techniques recognized as suitable through this study in the future. Further it is expected that this system would ease the burden of people during these hard times.

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Acknowledgment

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UxVote – Blockchain-Based E-Voting System for Secure Electronic Voting

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Abstract : Voting is a process of group decision-making or opinion-gathering that can be utilized to resolve any ideological disagreements. Voting on paper is still the most popular method. However, this traditional method of collecting votes is quite expensive and employs paper ballots. As a solution to this, a very secure and transparent solution is a necessity, which should also ensure the privacy of the participants. An e-voting system can be taken into consideration as a remedy to the problems that the traditional voting system currently has, and one of the technologies that are most suited for use in highly secure situations like this is blockchain. A hashing technique serves to strengthen the security of a blockchain, which is a decentralized system. Peer-to-Peer networks and a decentralized timestamping server make it difficult to manipulate or alter the data in this system. In this paper, we are presenting a safe voting system that was created using blockchain technology that allows voters to select one candidate from an existing group for major elections (e.g.: presidencies) and general elections. In this system, we used the Ethereum network, Ganache blockchain, and the Solidity programming language to create and test an example e-voting application as a smart contract for the Ethereum network. The records of ballots and votes will eventually be stored on the Ethereum blockchain. Voting requests are handled by the consensus of all Ethereum nodes and can be made by users straight from their Ethereum wallets. This agreement offers an open environment for electronic voting. With the help of this system, voting may be done more securely and affordably online.

Keywords: Blockchain, Smart Contracts, E-voting, DApps Ethereum

1. Introduction

With the proliferation of bitcoin worldwide, blockchain technology has become a considerable part of people's lives. Although the use of blockchain in its early years was only for monetary transactions and trade, studies show that it can be used in many areas beyond that when considering the high transparency of blockchain technology into consideration. Furthermore, in this P2P-based system, there is no requirement for a central authority to authorize or complete the operations. Consequently, all types of structural information are retained in this distributed chain;

including monetary transactions. The system is kept secure with the aid of specific cryptographic techniques. A large amount of information such as property records, marriage certificates, patient medical records, etc. can be captured using this approach/system after making any necessary alterations (Wood, 2014). A few years after Bitcoin's establishment, another cryptocurrency, the Ethereum coin (Ether), was developed. Now, Ether distinguishes the blockchain in its real sense by showing that this blockchain technology can produce software that can store data using the aforementioned structure. The blockchain contains immutable code that is used to enforce smart contracts (described below). Once they are written, they can neither be (illegally) erased nor altered. As a result, they are capable of functioning properly, independently, and transparently perpetually, without any outside influences (Maaten, 2004).

Voting is a method of group decision-making or opinion-gathering. Other ideological problems can also be resolved using this technique. This voting procedure is used to choose candidates for various positions in every Sri Lankan election. Presently, the paper-based system is the most popular and conventional means to cast a ballot.
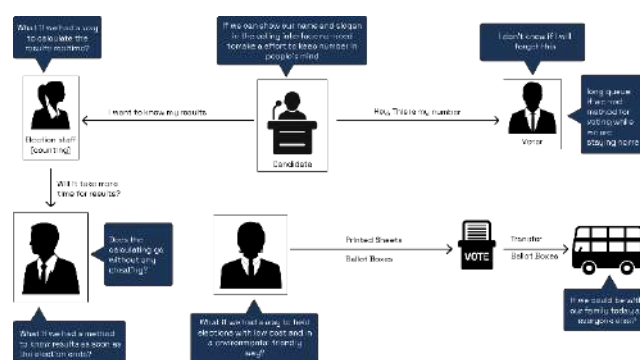
Figure 1 : Rich picture, how the current system process works and concerns at every stage

This time-worn technique has a relatively high cost because votes are collected using paper ballots. The ballot, the ballot box, the counting procedure, security, transportation, and many other expenses must be accounted for. Currently, this counting procedure is conducted manually. It takes time to carefully process and count all of these voter pamphlets at counting stations, and occasional incidents of election violence have also been heard. Cases of fraudulent voting and the violations that result from them directly undermine election transparency and public trust in democracy.

Consequently, there is a need for a reliable and secure voting mechanism today.

Comparing digital voting (or electronic voting) to conventional paper-based voting methods, digital voting is a better cost-effective alternative. However, governments are hesitant towards these approaches because of security concerns and people's lower technological awareness. However, a safe electronic voting system maintains transparency and security to the necessary level and reduces these expenditures, while also boosting the legitimacy of election outcomes (Tarasov and Tewari, 2017).

Nevertheless, blockchain technology may handle numerous difficulties outside digital trade, as a result of its distinctive distributed and secure concept. It might be a good option for projects involving electronic voting. E-voting is the subject of in-depth research, and numerous systems have been tried out and even employed for a while. However, only a few implementations are trustworthy enough to be used today. There are many successful examples of online surveys and polls, but we cannot make the same statement about online elections for businesses and governments. This is mainly because democratic administrations, which are the most popular form of government in the modern world as well as in Sri Lanka, depend heavily on free and fair elections. Additionally, in democratic nations like Sri Lanka, a robust election system that promotes openness is highly appreciated. A decisive election system that offers privacy and transparency is also what democratic societies prefer the most. Due to these circumstances, we are suggesting our blockchain based e-voting system, 'UxVote'.

Section II of this research paper focuses on the global need for a reliable and transparent e-voting system that addresses the flaws and limitations of the traditional voting system. Section III describes the complete technology behind a blockchain-based voting system, built using the Ethereum blockchain. Section IV elaborates on the web application that is used to host this voting system, its functionalities and how this application would function in a real-life scenario step-by-step. The conclusive inferences made through the findings of this research are discussed in Section V.

2. Literature Review and Related Works

Our primary driving force behind this project is demonstrating the viability of a trustworthy e-voting system using blockchain while offering a safe voting environment and increasing the citizens' trust in the elections, while being an economically viable solution for our nation. As anyone with a computer or mobile phone can use e-voting, every administrative decision can be voted upon by the people. At the very least, the public's view will be more visible and available to managers and legislators. Most importantly, this will eventually lead to actual direct democracy for everyone. It's crucial because elections can be readily influenced or corrupted, particularly in small villages and even larger cities located in corrupt nations.

Additionally, large-scale traditional elections are exceedingly expensive over the long run, mainly if there are millions of voters and hundreds of geographically dispersed voting centers. Plus, voters may be out of their relevant residential towns, making it hard for that specific voter to participate in the election and potentially lowering turnout. If done correctly, electronic voting will be able to address these issues effectively (Lin and Espinoza, 2007).

E-voting is a much older notion than blockchain. But all of the examples that are now known used centralized computing and storage models. Estonia is one of the best countries which were able to use a comprehensive and entirely online voting system. E-voting was first discussed in the nation in 2001, and it was formally implemented by national authorities in the summer of 2003 (Braun, 2004). Their system can keep going due to several enhancements and changes to the initial plan. It is currently quite robust and reliable as reported because for person-based authentication, they make use of card readers and smart digital ID cards for citizens that are distributed by the government. There is a unique web portal as well as a related desktop application that citizens can use to participate in the elections by selecting their choice from the listed candidates and casting their votes, so that anyone with a computer, an Internet connection, and their ID card can cast a ballot online with ease (Lohrmann, 2020). However, the Estonian model has numerous shortcomings, despite its considerable success and recent elections' penetration rate of 30% (approx.). By its very nature, the centralized approach offers a single point of failure and is vulnerable to hacking and hijacking attempts. For instance, Distributed Denial of Service (DDoS) assaults might damage the servers, databases, or applications that are being used. If they are unable to change the data, the administrators of such a system may act maliciously and manipulate some important information during an election. Plus, with regard to scalability, even though it works well in a country with a small population like Estonia, it is difficult to guarantee that it will work in a country with a large population (e.g., China). And this ongoing requirement for an ID card and ID card reader will not work in a cost-efficient system either (Koç, Yavuz, Çabuk and Dalkılıç, 2018).

Switzerland is also one of the few nations partaking in the trend of computerized voting. Every citizen of Switzerland, a country renowned for its extensive democracy, who has reached the age of 18 is eligible to participate actively or inactively in elections that may be held on a wide range of issues and for a wide range of choices (Ladner, Felder and Schädel, 2008).

A thorough study article recommends a robust methodology for a blockchain-based electronic voting system. The use of an intermediary unit between the voters' wallets and the administrators' wallets as well as the use of two different coin types for these intermediary coin (vote) transfers were additional countermeasures for voter privacy and vote anonymity that were explored by the designers.

Here, the intermediary unit gathers the coins (votes) given by the voters and converts them into another currency using that currency's wallet. Then, the intermediary unit delivers the new coins to their intended recipients (candidates). It is a very informative source, but it neither provides much information about the practical issues of implementation beyond the usage of Bitcoin and Zerocoin as the currencies, nor offers a thorough discussion of it.

Table 1: Feature comparison with existing systems

Features	Estonia	Switzerland	UxVote
User-Friendly UI	✓	✓	✓
Usage of Smart Cards	✓	✗	✗
Usage of Blockchains	✗	✓	✓
End to End Encryption	✓	✓	✓
2 separate channels for voting and user authentication	✗	✗	✓
Fully Automatic	✗	✗	✗

Our main objective is to concentrate on implementational tasks and develop our solution on a smaller scale in order to bring a general election process online, from elections for presidents, to elections for an organization's executive committee, and even for trivial matters such as student councils. The election process will be entirely online, so that everyone may participate in voting quickly in general elections (elections that allow voting for a single candidate at a time). We would like to conduct this in a way that everyone can monitor and keep track of the election process. Integrating online elections with the Ethereum blockchain technology is our main contribution to the idea of online elections. Only a few scholarly publications have examined the Ethereum blockchain as an e-voting option as of this writing (Meeser, 2017). The authors have presented a thorough and ostensibly safe protocol using the Ethereum blockchain, but their protocol involves complicated mathematical operations, and hence needs a lot of computing power, making it unsuitable for the Internet of Things (IoT). We created Ethereum smart contracts that enable vote verification and vote counting. Additionally, any Ethereum account can be added to the elections. The hash values of the accounts prevent identifying individuals.

3. Methodology

Following diagram illustrates the high-level system architecture of the system.
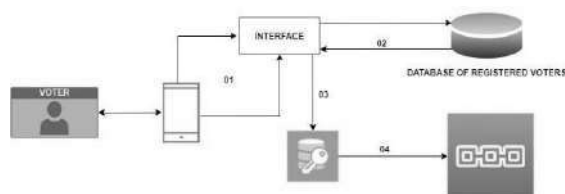

Figure 2 : Schematic diagram of the high-level system architecture

Request to vote (01): The administrator will approve the eligible voters with an Ethereum account number after the registration along with other valid information, such as their NIC, name and Ethereum account number. The system will allocate and grant permissions to the registered voters.

Casting a vote (02): Ethereum will create a token with an initial Boolean to cast the votes; however, the voters won't be able to do so until the token's value reaches 1. Voters will be given access to a simple and adaptable user interface for voting.

Encryption (03): To identify and validate system users, the system will produce a hash of the voter's name, confirmation number, and prior vote. This will guarantee the security and uniqueness of the information in the U-Vote e-voting system. The SHA one-way hash function is used to encrypt the data kept in the system. Data saved in the electronic voting system cannot be altered because they are linked to one another, ensuring the system's high level of security.

Adding the vote to the blockchain (04): Blocks are generated with the details required to store in the blockchain and blocks are linked to each other to produce the blockchain.

In this research, the Ethereum environment has been selected as the blockchain network and development platform of choice. Because of the strength of smart contracts, the Ethereum network offers a broader range of use cases than Bitcoin, which is exclusively designed to validate coinage transactions. These smart contracts allow many apps that typically run on a web server to be run without one. As a result, altering or damaging the intended software's source codes is challenging, if not impossible (Dzulfikar and Susanto, 2020).

All actions on the Ethereum network take place in real-time, or at least they are supposed to, and all blocks are added to the main chain in exchange for ethers, the network's cryptocurrency. These are awarded to the miners who carry out these time- and resource-intensive writing and validation processes. As indicated briefly above, we defined our smart contracts. These contracts were created using the Solidity programming language, which combines JavaScript and C++. The Ethereum network's peers execute smart contracts once every 15 seconds, and for them to be triggered, at least two additional users must validate them.

a) Why We Chose Blockchain Technology

We must find solutions to the following issues before we can conduct entirely online elections. The voting platform must be transparent, authenticated, and provable. We must ensure that the voters are actual people who use the legitimate identification documents we know for existing in electronic contexts. We must be able to show this at any moment, and we must ensure that our elections are as transparent as possible. As a result, we must collect and verify signed and timestamped election data. This ensures that once votes are cast, they shouldn't be able to be

changed. Additionally, we require individualism in elections to prevent voting for third parties.

These issues are not a concern when it comes to blockchain P2P technology. The blockchain allows us to define the necessary self-executing smart contracts, which is similar to creating code; including the definition of rules, objects and data models, so that contracts can begin to be carried out. Once established, smart contracts cannot be removed from the blockchain. A centralized organization is not required in the Ethereum network to deliver proof-of-work. The results of the contracts can be calculated by all of the peers without any influence. The Ethereum network has self-tallying capabilities (McCorry, Shahandashti and Hao, 2017).

In any case, using the original Ethereum network to try out new smart contract creation tools is expensive (because it costs some amount of ether to do so) and unnecessarily consumes a lot of memory. As a result, private Ethereum networks can be built and made accessible to developers so that they can test their programs without clogging up the main network. One such network is the Ganache personal blockchain, which we have also used in our research. Ganache comes with 10 free user accounts, which have 100 ETH (replica) for each account, which can be used for testing the smart contracts.

It should be emphasized that such test networks may have additional implicit or explicit rules or constraints.

To utilize a test network, users must first download a legitimate Ethereum wallet (the wallet which is used here is MetaMask) and then adjust the settings to change the connected network to the desired test network. MetaMask is available as both a browser extension and a mobile app. As this app is a web application, the browser extension was used here.

b) How We Programmed the System

In the Solidity programming language, the "Voter" object is specified as a struct. Voter was defined, and Voters were collected in an array. Voters have several characteristics, and they may have many more based on the use case situations. The variable named "isVoted" is a flag that indicates whether the voter has voted or not. Similarly, a variable called "vote" maintains the voter's preference among all candidates (defined as the candidate struct). "voterAddress" is a variable which is used to store the address of the voter account in the Ethereum network that is associated with an Ethereum wallet address.

The wallet address of the responsible person, who is the main administrator of the voting process, is stored in the address variable which is declared as "admin"; although he/she cannot interfere with ongoing (or completed) voting, he/she has the authority to initiate the voting process and the Voter objects that will be given to actual voters. According

to the system design, the very first Ethereum account gets the administrator eventually when deploying the election.

The individual who has the Ethereum address approved by the admin has the power to vote under this contract.

A function called vote() exist in the system, which is accessible by any voter whenever they want to vote (until the deadline). Voters simply send the ID of the candidate on which they want to vote as a parameter, and their votes are logged as a result. This function initially determines who is currently attempting to perform the contract's function. Furthermore, if the individual has the right to vote and has cast his/her vote, the person is listed as having already voted, and the vote count of the candidate of his/her choice is increased by one.

An arrow function called getWinner() returns the winning candidate's ID. It does not complete the voting process, but it always returns the winning candidate when it is executed. This function examines each candidate, counts the votes, and then returns the winner of the entire voting process as of the time of the function call, but it does not end the election.

The blockchain entries (blocks) pertaining to the vote creation and casting procedures are shown in detail in Fig. 3 and 4. Anyone monitoring the network can access this data in the open.
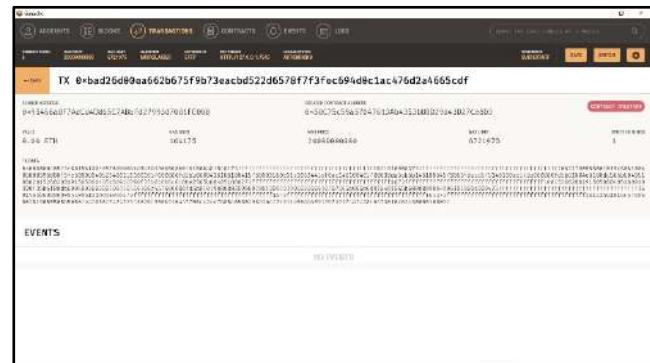

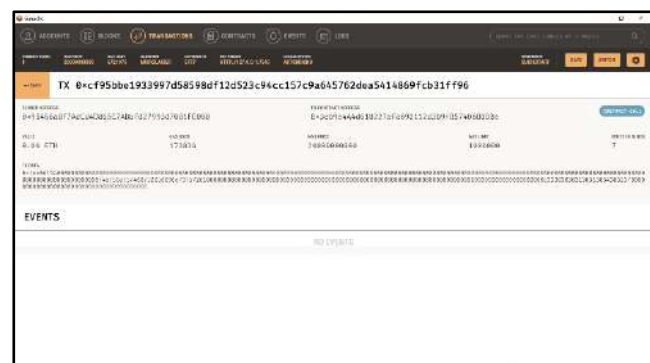Figure 3 : The blockchain entries (blocks) pertaining to the vote creation

Figure 4 : The blockchain entries (blocks) pertaining to the vote casting

Fig. 5 and 6 depict, respectively, the reception of a cast vote and a request for the end election. On the other hand, only the person who have performed the action have access to the data shown in the screenshots in Fig. 5 and 6. This is because the person who have performed the action's wallet account is the only place from which these records may be directly acquired.
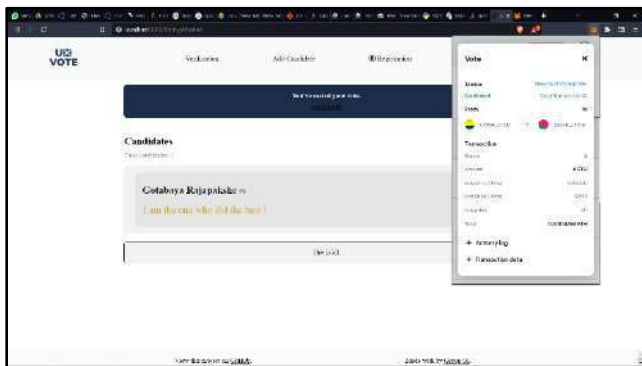

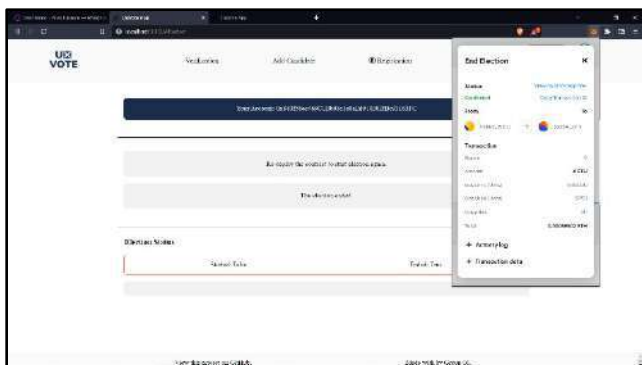Figure 5 : Reception of a cast vote

Figure 6 : Reception of an End Election Request

This project's scope is restricted to local presidency and general elections and polls. Millions of voters could present distinct challenges during a larger election. Presently, we cannot recommend using these contracts for nationwide elections because the Ethereum network's scalability is yet unknown and requires further study. These contracts are executed on the Ethereum blockchain, so this voting application may be utilized anywhere an Ethereum wallet can be run. The Ethereum wallet is currently supported on the Linux, OS X, and Windows operating systems. A voter should also have a small quantity of ether on hand in order to run the voting application and cast a ballot.

4. How The System Works

The very first Ethereum account receives the administrative functionalities after the election is deployed, per the system design. The owner of that account's private key will be granted administrative access, which will allow them to organize an election and add candidates to the database.

Only the administrator is able to see the interface below (Fig. 7 and 8), and from there, they can use it to set up an election. After entering the election data, such as the election title (05) and the organization name (06), the

administrator is able to start the election process (08). The "Start Election" button can now be clicked to begin the election.
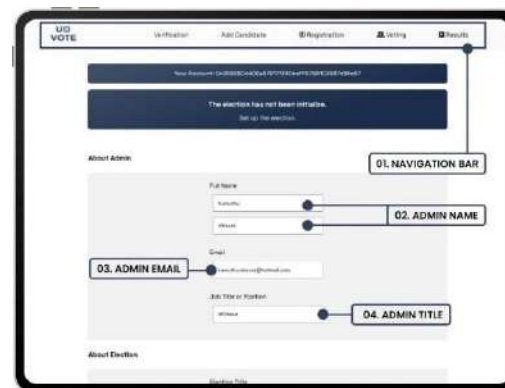
Figure 7: Election initialization (Page 1)

The button will not be available until you've finished steps 05, 06, and 07. When initiating an election, the administrator must supply their details, such as name (02), Email address (03), job title or position (04) from their end as well. Additionally, as an election cannot be started without the appropriate candidates added, a reminder to add them is displayed. The "Add Candidate" page will be displayed after clicking on "Add Candidate".

Figure 8: Election initialization (Page 2)

Without adding candidates who have been nominated to the election, admins cannot begin the election. As you can see in the interface above, there is a reminder mentioning the above case (Fig. 8). By using the navigation bar to visit the "Add Candidate" page or by using the link below the reminder, the administrator can add candidates both during and before the election setup. Both methods of adding candidates will take the administrator to the same interface, as displayed below (Fig. 9).

According to the system design, candidate adding functionalities are also available to the admin only, and candidates can be added to the election by completing the steps 10, 11, and 12. When initiating an election, the administrator must supply candiates' details, such as name (10), slogan/party (11). By selecting the "Add" option, the candidate can be included in the election. After steps 10 and 11, and only before the election begins, the "Add" button will be available.

The candidates who were added to the election will be listed below with their name, slogan, and index (13). This page also shows the total number of candidates who have been added to the election.
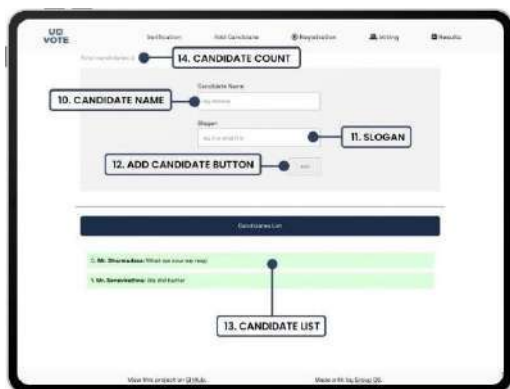

Figure 9: Add Candidate interface

In an emergency, if a user attempts to access the "Add Candidate" page by guessing the URL, an error message claiming that only the administrator has access to it appears. Because of this, users are unable to add candidates.

After completing the above steps, the admin gets the access to start the election, after which users get access to register as a voter for the election.

A card containing the voter's information will be sent to the administrator after a successful registration via their interface. The administrator can use their catalog to check the voter's information, and then they can simply authorize the voter for voting by pressing the "Approve" button, which is located on the same card. Administrators can still access the voter's information from their interface after giving them permission to vote, but they are not given the option to revoke that permission.

Figure 10: List of approved users, followed by the list of users to be approved

Here, the user's name (15), NIC number or the mobile number (17) that was recorded during registration will be displayed. Additionally, the administrator can also check the voter's status there, including whether they voted in their state or not. The interface shown in Fig. 10 will demonstrate the afore-mentioned functionalities. By clicking on the

"Approve" button, the administrator can accept the qualified users after checking the users' eligibility with their ledger manually. After selecting the "Approve" button, the "Verified" status displays "true" and levels up the user in the list as a verified voter.

After the election is set up, its details (22) are displayed as seen in Fig. 11 below. However, only the administrator can see the "End" button (24), demonstrating that only the administrator can end the election. Additionally, account details of users currently logged in (25) are also displayed here.
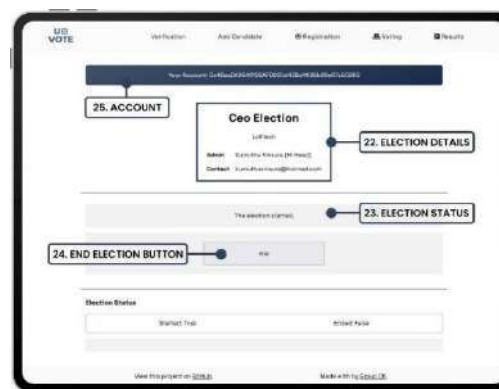
Figure 11: Home page after setting up the election

The user's web application begins to display the user interface as Fig. 12 after the election has been launched by the administrator. After the election is launched, the system becomes open for the user to sign up for the election. Steps 26, 27, and 30 of the registration process for "UxVote" must be completed by the user by adding their details including the ETH account's address (autofill) (30), name (26) and the mobile or NIC number (type of the number depends on the type of the election) (27). If the data entered is correct and valid, the "Register" (28) button will be accessible to the user. After the registration, the "Register" button will be visible again as the "Update" button (changed from "Register") and before the approval of the administrator, the users can change the details they have entered, if they wish to do so. After the registration, the users can see their registered details at the bottom of the Registration screen.

Figure 12: User registration interface

After the approval of the administrator, users can start voting by casting a vote for their preferred candidate. The

voting page (Fig. 13) consists of a list of candidates with their details. Every candidate has their name, candidate ID (33) and slogan/party (depends on the type of the election) (35) depicted on the list. Voters can cast votes for their respective candidate/s by selecting the respective "Vote" button (36). Additionally, the number of candidates who participate in the election (32) is also displayed in this screen as a usability improvement.

Figure 13: Voting page interface

A confirmation message will appear after selecting the "Vote" button to make sure that the vote is going to the right candidate, as shown in Fig. 14. By clicking on "OK" (37), the user can cast the vote to the respective candidate, and by clicking on "Canc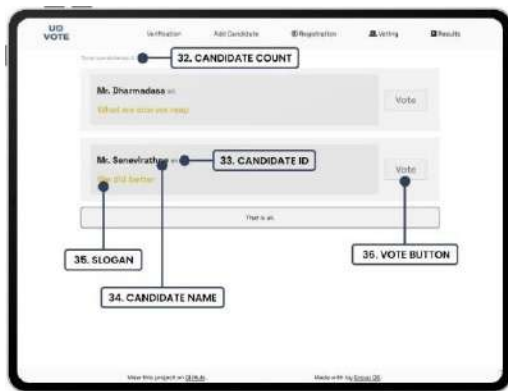el" (38) they can cancel their vote and select another candidate to cast their vote. After clicking on the "OK" button, the user cannot change their selection again.
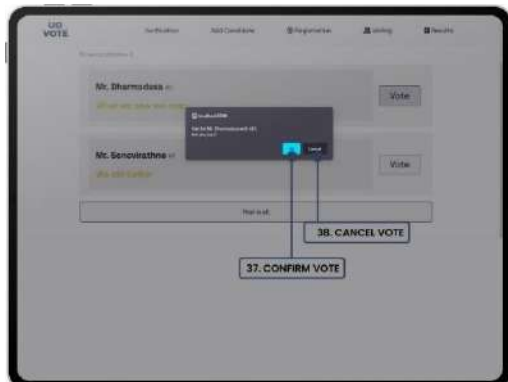

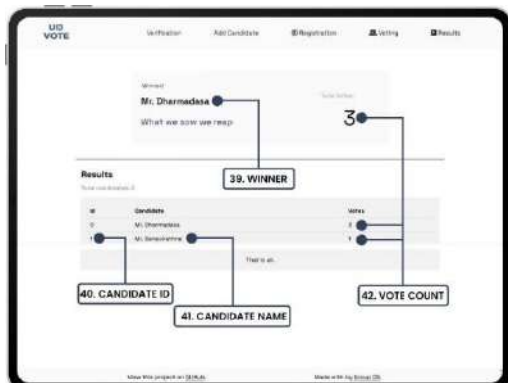Figure 14: Prompt after voting to confirm the vote

Figure 15: Election results report page interface

Fig. 15 above depicts the "Results" page, where the final results of the election will be displayed. The election's winner (39), who received most of the votes, is shown at the top of the results page, followed by a detailed breakdown of the election's overall results including the name (41), Candidate ID (40) and total number of votes (42) received by each candidate. Everyone who has the access to the result page can download a soft copy of the result sheet.

The notice "You're not registered. Please register first" will appear with a link to the registration page if the user hasn't registered. The message "Please wait for admin to verify" will be displayed if the user registers but is not yet accepted by the administrator (Fig. 16).

Figure 16: Voting page interface before and after the user registration

This system comes with a few pages which include some notices for the users that indicates the current state of the election, as a usability improvement. The Voting page is visible to users only with their account number. Before the election has started, a message is displayed stating "The election has not been initialized. Please wait…".

After the election is concluded by the administrator, the final results will be shown on this page as Fig. 15. The page will show a notification that reads, "The election is being conducted at the moment. Results will be displayed once the election has ended. Go ahead and cast your vote (if not already)". If the user hasn't already voted, he or she can do so by clicking "Voting Page," which is presented as a link at the end of the message, which takes the user to the Voting page.

5. Conclusion

The "right to vote" is a fundamental human right, and as such, voting is a critical concern of people. Nowadays, since everything is done through electronic devices, voting may also be done in this manner, saving nations and organizations a fortune. This computerized technology improves the voting process's efficiency and security. By utilizing the power of the Ethereum network and the blockchain structure, we were able to successfully migrate the existing manual voting system to the e-voting system, and from it, to a blockchain platform while also addressing some of the basic difficulties that existing e-voting systems face. As a result of this project, the notion of blockchain and the security approaches it employs, such as immutable hash chains, can be adapted to polls and elections. This accomplishment could pave the way for other blockchain

applications that affect every element of human nature. At this point, Ethereum and smart contracts, which made one of the most revolutionary breakthroughs since the blockchain itself, helped to transform blockchain from a limited perception of a cryptocurrency into a broader solution-base for many Internet-related issues of the modern world and may enable the global use of blockchain structure and its associated technologies.

E-voting is still a contentious issue in both political and scientific circles. Despite the existence of a few extremely effective examples, the majority of which are still in use, many more attempts were either unsuccessful in providing the security and privacy elements of a regular election or had substantial usability and scalability concerns (Hao and Ryan, no date). On the contrary, blockchain-based e-voting solutions, such as the one we developed using smart contracts and the Ethereum network, address many security concerns, such as voter privacy, integrity, verification, non-repudiation of votes and transparency. However, there are some aspects that cannot be addressed purely through the blockchain, such as voter authentication (on the human level, not the account level), which requires the integration of additional mechanisms, such as the use of biometric factors like fingerprints, face recognition etc.

The importance of decentralized systems is evident when considering the risk that storing registrations in a centralized location possess. This can always give officials the opportunity to physically view the voting records, which could lead to corruption and cheating from the authorities' end. Furthermore, in today's linked world, with the concept of the Internet of Things (IoT), many non-computer digital devices are expected to gain Internet access. It is important to note that, aside from phones, computers and tablets, many other common objects; even cars, are also now able to access the internet. Consequently, building a huge, distributed network which can reserve the required processing power will not be a problem in today's world. Additionally, such a system may not be suitable for important or official elections. The Diffie-Hellman procedure, which also presumes the use of random numbers and public/private key pairs, reportedly enables the holding of a "two-round" referendum with some ballot privacy.

The author would like to apply UxVote to all of Sri Lanka's election processes as the next phase in the research. Furthermore, this should integrate and include a user authentication module which makes use of biometrics in authenticating users.

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Towards a Decentralized Publication Platform with Authors Incentivized by Blockchain Technology

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Abstract :*Concerns regarding fairness, quality, performance, cost, and accuracy arise when science is published, and peer-reviewed. The Open Access movement has failed to deliver on all its promises, and intermediaries' publishers can still enforce regulations and profit concentrations. Existing publication platforms have several serious flaws. First, rather than encouraging extensive knowledge sharing, access to publications on publisher-owned platforms is typically charged. Furthermore, most present publication systems are prone to inefficient peer review since reviewers are not properly compensated for delivering high-quality reviews. A decentralized publication system for open research using upcoming distributed technologies like Blockchain creates a transparent governance. In addition to a thorough analysis of the methods, resources, and strategies put out in the literature to deal with the problems brought on by the development of the proposed system, we propose an application that makes advantage of the Ethereum blockchain to address all these issues. The system promotes peer review and develops its own reputation ecosystem as a substitute for the dominant prestige structure now in existence in academic publication.*

Keywords: *Open access, Blockchain, Ethereum, Editorial Management, Decentralized Publication Platform, IPFS, Peer reviews*

1. Introduction

Nowadays, Scientific research is centered on publishing in prestigious journals. The number of papers published in various journals can be used to evaluate a researcher's career. The quality of a journal is determined by a variety of impact variables. One of the issues in academics is the obsession with publishing. A research project should, ideally, result in papers in indexed journals. This concept leads to certain research papers yielding to reviewers' requirements or journal editors, potentially decreasing the originality or uniqueness of the work. Universities are increasingly encouraging scholars to publish articles in high-impact journals, making them concentrate on their research efforts on producing publishable results.

With only a few exceptions over the ages, publications in science and peer review have been built on a paper-based paradigm. Peer review is the process of determining whether an article is suitable for publication. The document is reviewed by a group of "experts" in a certain field, who then issue this judgment. Furthermore, this procedure has been critiqued in several ways (Souder, 2010). The financial rewards of scientific distribution are concentrated in a few publishers, and neither the authors, reviewers, nor readers benefit financially. Even though the Internet's expansion has allowed for the creation of new options for research dissemination (Eysenbach, n.d.) and assessment (Strother et al., 2015), the benefits continue to be concentrated in the above-mentioned publications. The decrease in distribution costs made scientific knowledge more accessible to a wider audience, calling into question the function of traditional publishers (Whitworth and Friedman, 2009). Nonetheless, universities are typically responsible for covering the expenses of accessing the papers published in these journals, which can be an awfully expensive sum in some situations (Bergstrom and Bergstrom, 2004).

The Open Access and Open Science initiatives, on the other hand, have successfully decreased the cost of accessing knowledge for readers [6]. Traditional publishers' business methods (Larivière et al., 2015), which now combine charging readers and charging authors, have not been successfully challenged (Noorden, n.d.). Editors who delegate a paper's review to a group of reviewers must rely on them in advance. As a result, the range of disciplines that can be examined is limited to those in which the reviewers are specialists. To widen this scope, the internet provides access to specialists in a variety of subjects from all over the world. However, when it comes to trusting complete strangers, there should be a mechanism in place that anyone can use to locate trustworthy individuals. Because they provide a positive initial impression of an unknown individual, reputation systems are the answer to these challenges (Hendrikx et al., 2015). Finally, peer review has received a lot of criticism, but just a few alternatives have received attention (Ware, n.d.). In the literature, there were numerous recommendations for open peer review (Ross-Hellauer and Walker, 2017) and reviewer reputation networks.

This paper proposes the development of a decentralized publishing mechanism for open science. Some scientific knowledge is publicly available from publishers because of the success of the Open Access movement. However, their infrastructure continues to serve most of the material (i.e., servers, web platforms). The goal of the proposed approach is to transfer infrastructure control from publishers to the scientific community. Three crucial functions of science communication must be decentralized as a result. 1) the selection and appreciation of peer reviewers, including a system for rating the reputation of reviewers 2) the dissemination of scientific knowledge via the peer-to-peer IPFS network, which offers an Open Access by-design infrastructure; and 3) the communication surrounding the peer review process, which uses Blockchain to offer a transparent and decentralized platform for communications related to the open peer review process, such as paper submissions, reviewer proposals, or review submissions. The novelty of this system is that owners of the publication material, can directly get paid for their work from readers, in the form of cryptocurrencies. None of the existing systems discussed in the following sections provide an incentive for the author. The structure of the paper is as follows. Section 2 compares the various peer review techniques now in use and presents a taxonomy of publication system features, from the literature. The approach and an overview of the suggested system are provided in Section 3. A summary discussion and several insights are provided in Section 4. Finally, in Section 5, we report the research's conclusions.

2. Literature Review

A. Publication Systems

In 1665, a process for producing scientific papers was devised (Rodríguez, 1998). But it was 45 years later, in 1665, that the first scientific journal, *Philosophical Transactions of the Royal Society,* was published ("Over 350 years of scientific publishing," n.d.). Editors were responsible for reviewing the papers that will be published in these publications at the time.

Instead of editors examining all the papers, an alternate system was implemented roughly 100 years later, in which a team of professionals in a specific field decided whether each paper evaluated was good enough to be published or not. This marks the start of what is now known as "peer review" [16]. It's tough to assess the quality of a scientific paper, but we now have several options for doing so, both before and after publication.

During the peer review process, experts in a particular field assess a paper's quality, indicating if it is suitable for publication. These reviewers read the manuscript and provide feedback as well as an "acceptance score" indicating whether they believe the paper should be approved. Only the reviewers are anonymous in "single-blind" peer review. The authors' names and backgrounds are known to reviewers, but the reviewers' names and backgrounds are unknown to the authors. Both the authors and the reviewers remain anonymous during "double-blind" peer review. As a result, this procedure could be viewed as a prediction of a paper's quality prior to publication (Szklo, n.d.).

Publishers own many journals with high impact factors. Many significant publishers have been around since the start. Despite this, publishers continue to benefit from the system by serving as middlemen between those who develop science and those who consume it (Larivière et al., 2015). The scientific publishing process might be transferred to fairer and more honest mechanisms in an era where information replication is no longer a cost.

Academic conferences are managed using software called event management systems (EMS) or conference management systems (CMS).

EasyChair ("EasyChair," 2022), a web-based EMS extensively utilized by the community, is possibly one of the most well-known. The following tools are included in this system: 1) paper submission; 2) review assignment; 3) author, reviewer, and conference chair email notifications; and 4) conference proceedings preparation. Another EMS that gives the similar tools as EasyChair is OpenConf ("OpenConf," 2022). It is only ideal for conference, workshop, or seminar events because it lacks project management tools. For its users, OpenConf offers two licenses: a free but restricted community edition and a "Professional Edition" with additional capabilities like as web and mobile connectivity.

Journals, on the other hand, are usually not responsible for arranging a conference or workshop, therefore they are not concerned with matters like scheduling or conference chairs. Authors submit their articles, which are then allocated to reviewers and either accepted or refused for publication. There are numerous platforms known as Editorial Systems (ES) (Lev, 2016) that may be used to monitor this process.

The publisher "Elsevier" uses Evise ("Evise," 2022), a web-based ES, to oversee the editorial process. This platform allows users to create a profile in Elsevier's database, which they can then use to subscribe to the publisher's publications. It also includes tools for editors, such as one that allows you to find, invite, and manage reviewers from a single screen, and another that allows you to generate and manage personal personalized decision letters, among many more. Despite their widespread use, all these platforms are nonetheless bound by the antiquated publication process in use today. For example, reviewers are kept anonymous even after the study is published, which means they are rarely acknowledged for their efforts. However, there are initiatives to change this, such as the one put out by Publons (Rajpert-De Meyts et al., 2016), a platform that allows users to make all their peer review evaluations public. Publons aims to reduce the anonymity of this process by encouraging reviewers to be recognized for their contributions to the publication of such changes. However, making reviews public is not always practical, as certain publications or conferences do not allow this sort of data to be shared.

Despite their promises, alternatives to these systems based on decentralized technology are still in their infancy. Recently, a few suggestions have surfaced, none of which are now operational. Aletheia is one of the most promising, a peer review concept that uses cryptocurrency to tackle some of the peer review socio-technical issues (Tennant et al., 2017). It does, however, require a crucial threshold of research community participation, as well as a change in real methods and platforms before it can be implemented. Apps based on the blockchain have also been proposed, including voting and publishing storage. A vast number of scientific papers are available only to those who pay for them. To put it another way, a substantial portion of the world's population is deprived of scientific information. *TABLE I* depicts the article processing fee and features of the publication systems.

Table 1. Comparision of Key Features In Existing Systems.

Key Features	EMS/ CMS/ ES				
	EasyChair	OpenConf	Evise	Publons	Aletheia
Paper submission				-	
Submit review	-				
Rate review	-	-	-		
Decentralized	-	-	-	-	
Author Incentive	-	-	-	-	-
Open access by design	-	-	-	-	
Article Processing Charge (APC)	£90.00 - £275.00	Starts at $250.00 per use	Can cost up to $9900!	-	No longer maintained.

( ) Available, (-) Unavailable

The comparison table shows that none of the systems provide an incentive for the author, the proposed system on the other hand will allow authors to get rewards from readers at tips for the paper they publish. These tips will be rewarded as cryptocurrencies to the author. Aletheia is the only decentralized system but is no longer active. Publons allows to import publications from ORCID, Web of Science

or Reference managers. Paper submission is not available but public reputation system for reviewers is available.

EasyChair has an Article Processing Charge that can vary from £90.00 - £275.00 depending on the license. If also comes with services to manage conferences. The one-time cost for OpenConf starts at $250.00 per user. There is no free trial available for OpenConf. Evise's Open access and Hybrid access submission differs according to the research area (Can cost up to $9900!).

Before a paper is published, its quality is evaluated through a process called peer review. To assist editors in deciding whether an article should be published, independent researchers in the relevant field evaluate submitted manuscripts for originality, validity, and significance.

Closed peer review is more usual, while the open peer review is gaining popularity, and both forms of reviews are encountered by authors and reviewers. Closed review has two versions, as will be detailed, and postpublication review (PPPR) is now being used in several journals. Each method has its own set of benefits and drawbacks.

A. Closed peer review

Closed peer review is a mechanism in which at least one of the parties involved in the review process–usually the reviewers–does not reveal their identity. Traditional peer review is usually single blind review or double-blind review. There are two types of closed reviews: single blind and double blind. In a single blind review, the author is unaware of the names of the reviewers. The reviewers, on the other hand, are aware of the writers' names, connections, and credentials. The writers and reviewers in the double-blind approach are unaware of one other's identities and institutional connections. This traditional model has long been known to have serious problems and has been criticized of being untrustworthy (Fang et al., 2012; Hames, 2014; Ross-Hellauer et al., 2017a), being unaccountable, and allowing social and publication biases to flourish (Kravitz et al., 2010; Kriegeskorte, 2012), and having a lack of incentive for reviewers (Benos et al., 2007).

B. Open peer review

Open peer review, as contrast to closed peer review, is a system in which authors and reviewers are acquainted throughout the process. Authors and reviewers' identities may be published alongside each other in an open review, with the option of include reviewers' reports. Reviewers' contributions are acknowledged by the publication of their names in the journal. Reviewers' contributions are acknowledged by the publication of their names in the journal. Critics, on the other hand, argue that open review may lead to less honest, critical, and rigorous evaluation by viewers fearful of retaliation. Critics contend that knowing the authors' identities, reputations, and institutional affiliations could influence the review process and lead to a biased result. We also think it is feasible that some reviewers are being too critical to look more rigorous to their peers.

C. Other peer review approaches

Advances in electronic publishing technology have recently permitted the establishment of a new type of review known as 'post-publication peer review' (PPPR), which occurs after the article has already been published. PPPR was initially only accepted as a complement to the peer review process, not as a stand-alone procedure (Azam Ali and Watson, n.d.). PPPR can be classified as either "primary PPPR" or "secondary PPPR." After first editorial checks, an unreviewed article is published in main PPR. It can then be formally reviewed by invited reviewers, like F1000 Research and Copernicus journals do. The article is published after initial editorial checks in secondary PPPR; however, it is available for review by volunteer reviewers. In both cases, the authors make changes to the manuscript in response to the PPPR criticisms, and the article eventually becomes a peerreviewed publication (Azam Ali and Watson, n.d.). (RossHellauer et al., 2017b) summarizes the benefits and drawbacks of the traditional peer review process compared to the open review process. TABLE II is a summary of different review approaches.

Table 2. Types of Review Approaches Summarized

Approach	Characteristic	Advantage	Disadvantage
Single blind	Reviewers are aware of the authors' names and affiliations.	Reviewer anonymity is ensured, allowing them to provide candid criticism.	Reviewers may make critical remarks or provide negative feedback.
Double blind	Authors and reviewers are completely unaware of each other's identities or affiliations.	The privacy of the reviewers is protected, allowing them to provide candid feedback.	Reviewers may make critical remarks or provide negative feedback. In specialized fields, reviewers may still be able to identify the author.
Open peer review	The identities and affiliations of authors and reviewers are known to each other.	When delivering feedback, reviewers are more courteous and constructive.	Fear may cause the reviewer to be less honest and critical of the product, resulting in a less honest and critical review.
Primary PPR	After first editing checks, a manuscript is published. The article will be reviewed by invited reviewers.	The paper can be discussed by a larger number of individuals.	It is possible for people to be unnecessarily harsh or nasty.
Secondary PPPR	After first editing checks, a manuscript is published. Volunteers serve as reviewers. Various publishers have different requirements.	The paper can now be discussed by a larger audience.	Unnecessarily harsh or negative people can exist.

3. Methodology

The decentralization technologies that the proposed system depends on are described in this section. It is suggested to use Blockchain to offer consistent behavior and IPFS to distribute content in a distributed system framework.
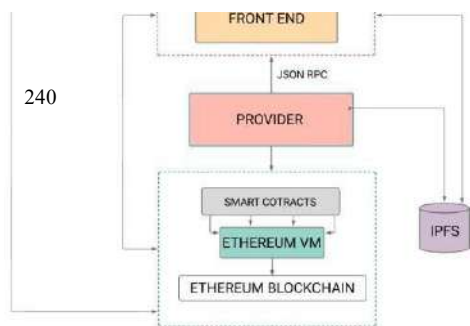
Figure 1 Overall Design Architecture
Source: Author

Figure 2 Use-case diagram of the system
Source: Author

The architecture depends on two platforms: Ethereum Blockchain for the system's logic and state; and IPFS for distributed archiving of papers. Ethereum (Buterin, n.d.) is an innovative technology that enables the development of distributed applications that run over any size and trustless network of nodes. Ethereum is built on the blockchain technology of Bitcoin, which is a public database where anybody can see all transactions. Ethereum implements this concept by deploying and executing code snippets on a distributed network using its own blockchain. These code pieces are known as "smart contracts," and they must be uploaded to the blockchain to be performed. Ethereum, on the other hand, has its own coin, "Ether." This currency not only behaves like Bitcoin in that it allows users to trade money, but it also acts as a fuel for the smart contracts' code execution, allowing them to execute their core operations for a modest amount of Ethereum.

The proposed system includes IPFS for distributed archiving for papers. IPFS is a distributed file system that is used to store all the papers that are submitted to the platform. This assures that all data is durable, free, and accessible, and that it is not reliant on a single server. It is a peer-to-peer filesharing technology that stores files in a distributed network using cryptographic hashes. IPFS is a BitTorrent-based protocol that works similarly to HTTP. It is like a massive git repository where anyone may save, distribute, and exchange files.

Messages and transactions can be signed using a Signer, an abstraction of an Ethereum Account, and signed transactions can be sent to the Ethereum Network to carry out state-changing activities. MetaMask offers an intuitive way to manage Ethereum user IDs and connects to IPFS and Ethereum through JavaScript clients. MetaMask is a decentralized program that aids with the execution of transactions on the Ethereum network. It can be installed as a plug-in in the web browser, and it will be activated anytime the user does a transaction on the blockchain network. It serves as a link between a decentralized web app and the blockchain network. Connecting to the main Ethereum networks, as well as any other custom Ethereum network, is feasible with MetaMask. It has an Ethereum wallet management feature as well as an account management feature. Keeping several accounts in different or the same blockchain networks is therefore simple. It also has a feature that allows you to retrieve your account.

Providers make nodes available to businesses and individual developers as a tool that enables them to create decentralized apps more quickly without having to invest their own engineering effort in maintaining and administering nodes. A more resilient web is made possible by Infura's ("Infura," n.d.) IPFS API and dedicated gateway, which connect apps of all sizes to distributed safe storage. Infura offers scalable, dependable, secure, and user-friendly APIs for IPFS and the Ethereum network. The infrastructure of an IPFS or Ethereum node is not a concern for developers. Angular will be used as the framework to implement the front-end of the proposed system.
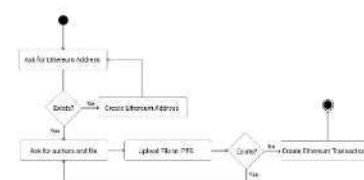
The use-case diagram describes the scope and key features of a system. The diagram above also shows how the system and its actors interact with one another (Figure 2).

Any user interacting with the system can have three roles including the reader, author, or reviewer. Authors are authenticated using their MetaMask wallet addresses. The author submits the paper and obtains rewards with cryptocurrencies. The reviewer can openly review the submitted papers, as a result gaining a reputation. The reader is able to search papers, tip authors for their work with cryptocurrencies, and preview the papers. The system's paper submission activity flow is shown below. (Figure 3)
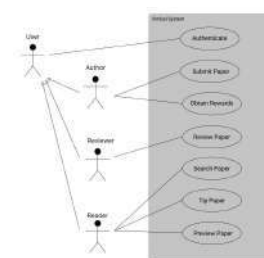
Figure 3 Paper submission activity diagram
Source: Author

To submit a paper, a transaction containing the Ethereum addresses of the authors must be transmitted. A node will upload this file to IPFS, and the resulting address will then be added to the transaction. If the paper exists in IPFS then the paper is already owned by another author this user will be notified and prompted to submit another paper. The system as a platform consists of several inputs the manuscript or the publishing material itself is an input to the system. The meta data required for the publishing material is also entered by the author. The reviewers can publicly review the published material by providing feedback.

First the author (generally could be anyone using the platform) submits the research material to the platform, the file uploaded is converted to a byte stream which is then deployed to the IPFS through a provider named Infura. Once the file is deployed to the IPFS a hash of the IPFS address is returned. This and the metadata are then saved to the Ethereum blockchain using Solidity Smart Contracts. Once the data is stored in the blockchain the published research material is openly available for anyone in the platform to access. Users are free to give feedback to the author through reviews.

The output is a distributed application (dApp) that allows researchers to publish their work and gain rewards in the form of cryptocurrencies. The publish material is openly accessible to anyone in the platform. Users who are willing to encourage the author can tip the author with some amount of Ether.

4. Discussion

In addition to enabling new modes of research distribution, distributed technologies like blockchain and IPFS may finally fulfill the promise of Open Access. Decentralizing and opening the infrastructure increase the system's transparency

and accountability and might open new opportunities for innovation. Since the suggested system is geared toward giving authors an incentive, it does depend on the use of cryptocurrencies. The peer review approaches mentioned have their own pros and cons as from the literature. The nature of the proposed system highlights the issue of using peer review methods such as closed and open peer review. The lack of a centralized authority makes managing the reviewing process cumbersome, on the other hand peer review approaches such as secondary PPR provides motivation to the reviewer to gain reputation by providing reviews. The openness made possible by making the peer review process public raises questions about fairness and privacy while also enabling the development of a reputation system for reviewers. Despite the difficulties, we are certain that decentralizing the scientific processes would create a whole new field with effects we cannot possibly predict. Soon, we plan to evaluate the results of the conducted survey on the peer review approaches conducted, to analyze the drawbacks of various methods. All communications with the platform are recorded in a chain of blocks, making them all publicly accessible. Regarding peer review anonymity, this could be a significant issue. In peer reviews, anonymity of reviewers and authors is routinely employed to enhance the process's fairness. Single blind evaluations allow anonymous reviewers to constructively evaluate an article without worrying about the authors' replies. Additionally, double blind evaluations enable the impact of individual biases to be lessened. Finally, open review models suggest that authors and reviewers be acquainted. However, reviewers' anonymity can also be exploited against them. The lack of sanctions meant that the system didn't prevent unfair or substandard reviews.

5. Conclusion

The goal of decentralized Science is to challenge the technical infrastructure that underpins conventional publishers' middleman role. The existing publication platforms charge the author and reader in some cases which is a challenge to the scientific community. As a result of the success of the Open Access movement, certain scientific knowledge is now freely available from publishers. However, their infrastructure continues to provide most of the material (i.e., Servers, web platforms). Because they own the infrastructure, they have control over the scientific community that creates the material. It is also important to keep in mind that peer reviewing is a volunteer activity, which means that reviewers are not paid for their time and typically conduct evaluations on their own time. It is critical to make this task as pleasant and enlightening as possible. Recognizing reviewers for their contributions by publishing their names in the publication or awarding them honors and cryptocurrencies can be a successful tactic.

For open research, a decentralized publication system, which will improve the availability to those who are unable to access paid content. Students will have more material and funds will be able to go back into teaching, if schools and universities do not have to pay costly fees for access to a small range of research papers and instead have a vast range of papers available for free. If more individuals read more scientific studies, there will be statistically more people who connect the links and uncover scientific discoveries. Finally, the financial benefits of publishing might be dispersed across the scientific community, allowing for new types of project funding.

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Computer Game Industry and Economy Growth: A Study on How Blockchain Computer Games Make Impact on Current Economy Crisis in Sri Lanka

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Abstract: *Globally computer gaming industry is a vast industry which rapidly changing with new technology. At first, gaming was just for entertainment purposes. Over the years people played games but did not earn money from them. Cryptocurrency and blockchain technology are game-changers here and created the economic system around the computer gaming industry. At present gaming industry is growing rapidly changing with these new technologies and gamers are allowed to earn income from playing games. On the other hand, introducing this play- to-earn game model for computer game developers and game development companies increased and still increasing their annual revenue. Here the game changer is the blockchain gamification known as NFT games or W3 games. Blockchain gamification created an entirely new economic system around the globe and created a direct impact on economic growth. Meanwhile currently Sri Lanka going through an economic crisis and need solutions to become normal and grow back. The researcher's goal is here to identify the impact of blockchain gamification on the economy, and how to implement and identify what is the business model suitable for Sri Lanka. Implementing blockchain gamification gives a solution to the current economic crisis and changes the current economic ecosystem. Globally even in covid 19 pandemic other countries started blockchain gamification and even business owners moved to it to earn their daily income and succeed. With the current situation in Sri Lanka, as a solution to the economic crisis, people can move to blockchain games, earn income, and help Sri Lanka's economy.*

Keywords: *Computer Games, economic crisis, Blockchain, NFT(Non-Fungible Token)*

1. Introduction

The computer gaming industry is a rapidly growing industry worldwide. Mainly popular and functioning as a wide industry in United States and Japan. Other than that, in many countries the gaming industry impacts on their economy similar to software development industry or even make greater effect to the county economy. Considering county like Japan and computer gaming industry the game development companies always go beyond with the technology, even create a game culture and make it as one main source of income while popularizing their games in local and global aspect. When considering Sri Lanka's computer game industry, it is still in the young stage but growing rapidly with the new technology. But when considering the economic impact to the Sri Lankan economy still has not created a greater effect and still functioning under IT industry in Sri Lanka. When considering the gaming companies there are few or there is a separate game development division in an IT company which is not sufficient to make an impact. But if industry experts, game enthusiasts, game developers gather up and form this computer industry as a firm industry there is a possibility to make an impact to the Sri Lankan economy. In present days Sri Lanka going through an economic crisis and if implement a good business model, new technology this computer gaming industry can grow and with that growth it can impact on the economy and helps to overcome with the current economic crisis. Before going to the solution should get an idea about current global market overview of the computer gaming industry.

A. Global Market Overview

In the 2021 the gaming market was valued at USD 198.40 billion and it is expected to reach a value of USD 339.95 billion by 2027, registering a CAGR of 8.94% over 2022-2027[2]. Staring 2019 due to covid 19 pandemic people turned to game platforms to pass their time. Mainly because of this reason the gaming platforms attracted thousands of new visitors and even cause online traffic.because of this cause the gaming industry revenue and market value increased .

With the technological advancements the gaming industry facing a rapid growth and enhance the gaming experience of the users. When considering gaming experience, the game developers continuously launching and rewriting codes for diverse platforms such as PlayStation and Xbox incorporate into a standalone product and provide gamers a cloud platform. Providing cloud technology in the gaming market is helps to drive the demand and engagement of multiplayers for different games. This helps to boost the market growth specially during the covid 19 pandemic period. Also, Cloud gaming services focus on providing hyper scale cloud capabilities, streaming media services, and global content delivery networks to build social entertainment platforms. These factors have an anticipated positive impact on market growth.

Mobile gaming is the most using gaming form globally. Main reason for mobile gaming's popularity is accessibility. Also the increasing demand for mobile games results to use technologies such as AR, VR, cloud gaming to improve user experience [2]. Between year 2020 and 2021, many

changes occurred in the mobile game development sector. One important thing is found a way to reduce the cost of the development process through conducting an early CTR (click-through rate) test for hyper cause mobile games and it helped to increase market value.

Meanwhile Asia Pacific region is anticipated to hold the largest market share in the gaming industry, with China, Japan, and South Korea showing high potential for market growth. Economically China is one of the Asia's most important country which increasing technological usage and adopt to new technologies in short time period. With covid 19 China found an opportunity to spread gaming industry throughout the country and it helped to increase users and increase the annual revenu from the gaming industry. In china many use the WeChat mobile app and people has started to play mini games within the app. These mini games have large following across the country. Considering Japan, has best gamers and has a rapid growth with technology adaptation. For example, the computer game revenue from 1982 - 2013 illustrate from following diagram and can see how much higher revenue Japanese companies earned even in 80's.
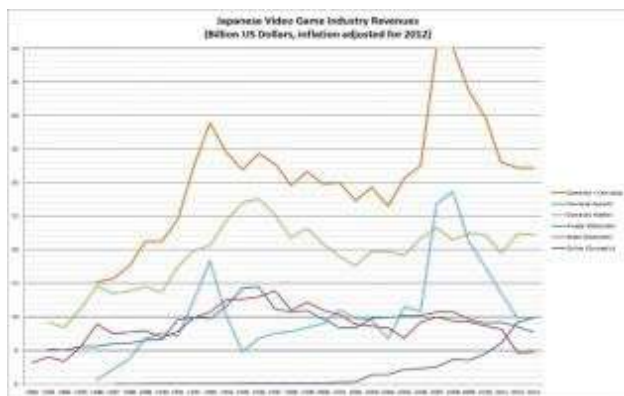

Figure 1: Japanese video game industry revenues from 1982 to 2013, adjusted for inflation.
Source:
https://vgsales.fandom.com/wiki/Video_game_industry

Blue - Domestic Japanese arcade market **Red** - Domestic Japanese retail market, including the console, handheld and computer sectors (hardware and software) **Purple** - Domestic Japanese mobile game market **Green** - Total domestic Japanese video game market, including all sectors **Cyan** - Japanese retail exports (hardware and software) to overseas markets (console, handheld and computer sectors) **Orange** - Overall Japanese video game industry, including both domestic Japanese market and overseas retail exports

Korean computer game giant NCSOFT Corp. released Blade & Soul 2, the sequel to its famous multiplayer online role-playing game (MMORPG), for PCs and mobile devices. According to the company, the highly anticipated cross-platform game had drawn 7.46 million pre-

registrations, a record in the country, trumping NCSOFT's other hit MMORPG "Lineage 2M", which drew 7.38 million users[2] and that is how Asia pacific region leading the gaming market.

Figure 2: Gaming Market - Growth Rate by Region (2022 - 2027)
Source: Mordor Intelligence

2. Computer Gaming Industry In Sri Lanka

Globally gaming industry has entered the golden age of gaming. The past year have given rise to a massive influx of new gaming media, gamers, developers, and gaming companies worldwide. The advancement of technology and the high level of adoption of games have led to gaming becoming a multi-billion-dollar industry. Regardless of the form of gaming; PC gaming and Console gaming and Mobile gaming will be the front line in present and future which evolves faster than one to other.

Even though there are many gaming studios who built local and global games in Sri Lanka the data and statistics about the industry, growth of the industry throughout the years are fuctuating gradually. The one reason behind this is the gaming ecosystem in Sri Lanka is still quite young. Meanwhile some of the mobile service providers such as Dialog (example: the axiata Game Hero tournament with PUBG mobile) operate and have their own gaming tournaments and run their own gaming platforms. Specially since 2019 covid pandemic situation to up to date in 2022 the mobile gaming growth increased due to internet penetration and digital payment. There are key factors to boost the turnover to the mobile games such as; online education increased the screen time, increased popularity of e-sports, use of advanced technology which captures the attention of the youth, innovative concept-based games, and games which offer monetary rewards.

According to statistics of AdColony, one of the largest global mobile advertising platforms, there are 4 million active mobile gamers in Sri Lanka, who spend 20% of their time on the mobile on gaming. The statistical data gathered locally through gamer.lk shows that two to three million Sri Lankan youngsters between the age eighteen to twenty four are very interested and involved in gaming. Because of this trend by the end of 2022 worldwide mobile game development companies will highly lean towards into the gaming industry to target the youngsters. These youngsters are mostly from urban areas. So, there is a large untouched market that resides in rural and suburban areas of Sri

Lanka. The smart phone usage because of the online education and the growth in mobile gaming, streaming will help to reach this untouched market. If Sri Lankan gaming companies take these demographic factors into consideration, the organizations will be able to easily access to a wider user base. Meanwhile there is a sub market for gaming equipment that has started to develop due to the gaming industry growth. The increasing number of gamers make these purchases through online channels.

Globally, the use of VR (Virtual Reality) gaming increased but the lack of access to required technology and the high cost of VR headsets preventing such gaming experience in Sri Lanka. But as a solution for this fact can introduce mini gaming centers which provide VR gaming experience and through that strategy gamers can experience the VR gaming and can earn income than the PC game, console game or even than the normal mobile games.

Meanwhile gamers enjoy gaming, worldwide people enjoy watching gaming. For example, techno blade who was Minecraft gamer and game streamer, the twitch streamer Byron who knew as Reckful passed away and when they die, they had millions of followers in their YouTube channels who watched these gamers live streams and become their fans. Even in Sri Lanka there are popular game live streamers who showcase their talents virtually to those who enjoy watching gaming others extraordinary gaming skills, or who spend time to learn strategies to win next levels of the particular game levels, and some are just engaging personalities to gain a following. Many game streamers earn money from these live streams.

Even though there are such gamers still there is a lack of knowledge among gamers, potential gamers and even the viewers on the games are not much aware of the depth of the game and both Sri Lankan gamers and viewers are not aware about several gaming platforms that are available in Sri Lanka. If gaming companies pay attention to these factors and address them companies will be able to achieve possible benefits. Meanwhile as per Sensor Tower's Industry Trend Report in this year 2022 gaming industry expected to dominated by Hyper casual games. In nature Hyper casual games are easy to play and allows people to have fun and relax without using the left brain or called the intellectual side of the brain. These types of games are yet to dominate the Sri Lankan gaming market and at least one gaming company introduce this game that will beneficial to them.

The rapid growth of the gaming industry has created the path for international gaming competitions and has become a such sport which able to draw large audiences quite similar to physical sports. Gaming industry is a profitable industry with international tournaments and large cash prizes. In Sri Lanka Gamer.lk and The Sri Lanka eSports Association support Sri Lankan teams and have taken part in international tournaments. But the tradition should improve to make impact on the economy.

3. Business Model to Grow Computer Game Industry

Either PC gamer or Console gamer with the current situation in Sri Lanka it is impossible to afford needed items such as; Play Station 5, VR headsets, SteelSeries Apex Pro Keyboard or PC gamers to do a system upgrade with new NVIDIA RTX 4000 GPU (Graphics processing unit) with current high market price. With this situation for gamers have to stick to mobile games or play games which are suitable for their existing systems. As a solution game developer communities can focus on mobile game development and develop PC games such as Arimac Digital, Sri Lanka's flagship PC game NERO to play in the existing gaming computers. Meanwhile developers should focus on to develop advanced games which able to go globally and form a unique computer game development industry and gain a recognition and through the recognition earn income. These aforesaid method of introducing more mobile games to the community is good but need more solid business model to secure, improve the computer game economy in Sri Lanka.

The solid business model is developing NFT games or crypto games or name it blockchain games. This NFT games are predicated to become the predominant business model in gaming within ten years of time. Further, the NFT games are a better business model for funding games. For example, when someone invested in a new web3 game and inside of the game gamers building a mafia metaverse and raise $3M in their initial NFT drop. NFTs allows access to new capital market and raise capital from the crowd. NFT games will open economy paths, and by building the games on programmable assets (tokens + NFTs) can create economic value than a single game. NFTs are beneficial for gamers. Gamers can have ownership of the assets they buy like in physical nature, earn through game and can go to next levels of the game while collecting assets. Years ago, game development companies switched to the model of selling game items, cosmetics to gamers. But currently the digital stuff gamers buying is not resellable. So now NFT ownership allows to resell the purchased items. With this NFT near future games will be fully robust and will have programmable economies. Developing NFT games will be a better business model and will able to cause a good impact.

4. Modern Gaming Economy: Blockchain / Nft Games

From the beginning of blockchain game development and start of the games like CryptoKitties craze, NFT games have developed and started to offer play to earn models. That is the beginning of the mix of world finance and gaming, providing gamers to earn income as they play and increase the performance of the games.

Gamers no longer need to keep on winning, finding, or breeding a scarce collectible worth thousands of dollars. Gamers can experiment with multiple gaming models in various themes aside from collectible animals.

When considering about NFT, known as Non-Fungible Token is a digital, cryptographic token on the blockchain representing a unique item. The Non-Fungible means each token is unique and cannot swap identically for another token, but can trade 1 BTC (Bitcoin) for another 1 BTC which are equal.The case is when it comes to trading this is impossible specially in NFT art trading.

NFT can come with different forms. NFT could be a digital asset in a game, a collectible piece of crypto art, or even a real world objects like real estate.Also, NFTs have solved one issue of ownership in a game and creating decentralized digital collectibility.

Play to earn NFT games give a chance make income stream through playing. A gamer is rewarded with tokens. They can earn more the longer they play. Normally the tokens earned are often needed as part of the games crafting process. Token method is more stable and tokens can be earned through play.

NFT games are especially popular with the users in low-income countries. The reason behind is these NFT games boost fix income. By playing NFT games like Axie Infinity many gamers are making approximately 720$ per month and $8500 annually [5], and some even more than that depending on the market price and time invested. The most popular NFT games are Axie Infinity, Sorare, Evolution Land, Gods Unchained, CryptoKitties, Splinterlands and Alien Worlds.

Figure 3: Existing Blockchain Games

Source: https://www.quora.com/What-are-some-NFT-games

NFT games are having game assets that are owned (act like they held in custody wallets) by gamers in the form of Non-Fungible Tokens (NFTs) or Fungible Tokens. The function of this innovation is that player assets are tangibly owned and able to sell those assets or trade just like physical goods.

Worldwide, NFT games like Zeedz (a Play for purpose game) [6] are currently the most heavily invested sector of the games economy. Considering information, gaming infrastructure technology companies have invested billions of dollars in NFT games in the early months of 2022.

When considering benefits of the NFT gamification should think in two ways. One is Gamer's perspective benefits and other one is developer perspective benefits. When considering gamers side gamers can invest through computer gaming by selling or trading gathered assets like skins or other equipment's. Also, some NFT games allow to make 100$ approximately each day, and sell assets that have gone up in price which able to bring more income. All NFTs stored inside the code using blockchain technology. To see it have to decode it. Because the record is encrypted and stored in the blockchain codebase even NFT is transferred to new owner there is no place to a imposter. That is why NTF has Proven ownership. NTF games offer as asset collection. Therefore, the NFT owner can sell or trade when needed and earn revenue. With all these technology people will consider about the security of the gamer's wallet. For that also have given a solution using blockchain technology so that gamer can secure his digital assets and digital wallets.

When considering game developer/ company perspective they invest lot of money on a NFT gamification platform and then again spends a lot of money on branding. After go live stage and branding other companies identify these NFT gaming solutions and tend to invest on the game specially because of the blockchain. Moreover, there are chances to attract venture capital. Suppose game developers newly added the feature of NFT. That opens new revenue opportunities, increase ratings and draw new gamers to the platform which is beneficial for both parties. When NFT token is exchanged or sold to another gamer the owner of the token can charge a transaction fee from the crypto wallet or exchange fee from the owner. Some such token transaction value might often reach millions of dollars which result big transaction charge. Meanwhile like for all apps the development team will get app store or play store earnings. The game owners receive a share of download charge and each new download will increase company income.

In Sri Lanka already have gaming portals with subscription models, but these models are not revised to be with accepted gaming industry standards where can experience clear options such as free to play, pay to play, play to win and play to earn. As mentioned before NFT games consider as play to earn, play to own, crypto, blockchain or Web3 games are digital games which use blockchain technology as game economy. Sri Lanka should set clear standerds for play to earn in computer gaming industry and allow gamers to play NFT games and in other hand facilitate game developers, companies to develop more NFT games, release them to the global gaming platforms and earn revenue from it.

5. Nft Gamification: How To Build a NFT Game

Considering the current economy situation in Sri Lanka game developer should pay attention to create NFT games. Here in this research, this section provides an insight about creation of NFT games. As the very first step should choose the game model; whether it is play to earn (P2E) or free to play (F2P). F2P games are rare because they do not require any initial cost and can start to play right away. But with the concept of P2E satisfy the fact of creating NFT game because to start playing the gamers must purchase first NFT. Further, P2E games allows gamers to earn utility tokens (utility token - considered more stable way of earning than the NFT only method) and buy NFTs which represent characters, perks, or power ups. After deciding the model next step is choose design for the game. Which means select the genre (strategy, combat, adventure, simulation, role-playing, or card games) of the future game. After that should conduct a competitive analysis to find similar games on the blockchain gaming and should not copy successful games and the features. Similar to normal game design all information should recorded in the game design document to avoid misinterpretations within the development team. There in that document can define the characters, their system, victory conditions and monetization features. Next the design phase. Game designing is an art form and developers are free to do anything. But have to consider about other existing NFT game character designs. For an example the most popular NFT game is Axie Infinity which consists fantastic NFT animals that can be bred or sold.

Then choose the platform; Web or Mobile application. Applications built on blockchain technologies are called dApps – decentralized applications. The main code and data (backend) of a decentralized application are stored and executed on the peer-to-peer blockchain, unlike client-server applications, whose data and code are processed on servers.[10] So both are valid. Web applications can be launched from any device meanwhile mobile apps (can be native or cross-platform) run much faster on smartphones but the development is expensive when considering the web application. There is another option called hybrid app or PWA (Progressive Web Applications) which works as both mobile app and web app. PWA allows to run the application using a mobile browser. First define the target group and the devices they use and then choose web or mobile or hybrid platform accordingly.

Then choose suitable technology, mainly the common dApp (decentralized application in blockchain) development platforms are Moralis and Truffle Suite. The most common dApp (decentralized application in blockchain) development ecosystems is Truffle Suite. Truffle Suite provides blockchain developers with a standardized testing environment and asset pipeline to create high-quality and reliable smart contracts.[10] This Truffle suit consists of three parts namely Truffle, Ganache and Drizzle. These three parts differ from the development environment, Virtual machine specializations, security and managerial interfaces**.**

Then create the virtual/crypto wallet which is locate in the blockchain ecosystem. This crypto wallet is a special software that allows to store digital currency and perform some related operations. Also, gamers use this wallet to register to the NFT games. Moreover, this should implement in the development phase. These crypto wallets should have high security, private and public keys. As an example, CryptoKitties uses the MetaMask non-custodial wallet. It works as an extension for the Google Chrome family of browsers.[10]
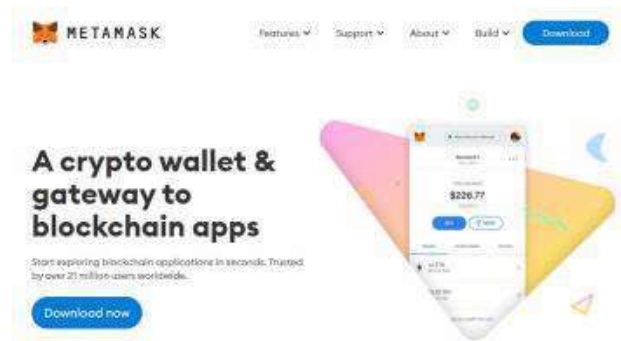

Figure 4: MetaMask crypto wallet

Source: https://kevurugames.com/blog/how-to-create-an-nft-game/

In mean time should consider about smart contracts. Smart contracts are programs which stored on the blockchain that run when certain conditions are met and smart contracts responsible for the NFT movement, the cyber-security of a game, and customization of transactions. Also, once smart contract built cannot be rewritten. When gamers accessing to their NFT first the front end receives the gamer's address from the crypto wallet, then front end sends the gamer's address to the smart contract and the smart contract gives the gamer the NFT address owned by the given user. To build smart contacts use programming language like Solidity. Solidity is a language which can create complex contracts in a well-defined code format as known as Turing complete language.

When considering the back end as mentioned already use smart contact and it deals with the URL of desired NFT. With this URL the front end makes a request to the back end to get the metadata for the required NFT. Then back end sends metadata to the front end. After receiving metadata, the front end can send another request to the server with the NFT URL. The interface can then display the available data and the user can see their NFTs name and image. To do this process for the back end can use node.js which translate javascrip into machine code that runs on the server side.

Then should test NFT games. First developers conduct unit testing during game development phase. After developing each part of the game, test them and fix critical errors immediately. Then QA engineers do the alpha testing and do the Beta testing with real world gamers before launch it on the market. For this should use blockchain test methods

like Rinkeby or Ganache by Truffle. Other than mentioned main testing methods should do blockchain functional testing, security testing, UI testing and integration testing and API testing. Last not but least then the go live phase and the maintenance.

If summarize the steps to create a NFT game, the steps will be; Step 1: Pre-production - Bring game development expertise onto your team, gather data, Define the concept, Define the platform, Choose the right tech stack, Create a GDD (Game Design Document), Prototyping. Step 2: Development - Modeling/Art design, Level design (logic of a game, designing the quests), Setting up the wallet, Smart contract, Coding. Step 3: Testing - mainly do the Unit testing (Functional game testing and Non-functional game testing), Alpha testing and Beta testing.Step 4: Deploy and promote.

Suppose game development company needs to add NFTs to their existing game. Is it possible to add NFTs like that? Answer is yes. Turning a traditional game into NFT game is possible if the game developer is able to create smart contract and insert it into code which is bit similar to game porting. Both processes do is edit the game code and adapt game mechanics, content to the new game format. Transferring traditional game to NFT takes broad scope and resources. So to do this transformation game developer have to look into three main processes. First keep the game balanced. When NFTs inserted to traditional games it may imbalance games. Every game component must be adjusted to the new format so that new settings do not clash with each other. Second is maintaining structure and functionality. Even after implementing NFTs, developers have to keep quality of the factors like game structure, mechanics, functionality, device compatibility, load capacity and optimal performance. Finally, the third step is to maintaining an optimal size to quality ratio. After implementing NFTs the final game size must remain optimal for the platform. It is challenging to do so while maintaining the quality of each component of a game. according to aforesaid facts can turn the traditional game into NFT game but it takes many resources and such decision should take carefully.

6. Posssible Economic Impact To Sri Lanka From NFT Computer Games

Globaly there are many examples of communities which highlight the potential of NFT games building a new economy. The video called What play-to-earn gaming can tell us about the future of the digital economy — and the metaverse [12] describe about how Axie Infinity popularized in the Philippines and how the gamers play the game and earn income. According to the reports Philippines and Venezuela also facing for a economic downfall and people are unable to earn even daily wages. So some of them start to play NFT games like Axie Infinity and earn at least 60$ per day. What they do is play the game, earn tokens, then sell it in crypto currency and then convert them into the real money. They use that money for their survival. Gamers in economically challenged countries like

Sri Lanka can earn income inside the digital word. That is far more significant than physical economy.

If some gamer cannot afford the game character or feature there are platforms called scholarship platforms which helps to purchase characters, features and educate gamers about this digital economy by encouraging to participate play to earn NFT games. In Sri Lanka's case this can happen and for global NFT games locals can build such platform and earn income. When it comes to game developers and game development companies, they can createnft games and send to local and global platforms and contribute to the economy.

7. Conclusion

This paper aimed to give an insight about blockchain games, how to develop such game and how NFT computer games impact to country economy. Creating, playing NFT games there is a possibility to contribute to the current economic crisis in Sri Lanka. Also, can develop the existing computer game industry in Sri Lanka to the next level and make it a profitable business.

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Story Catcher: e-library to Improve Early Literacy Skills and Verbal Fluency in Kids

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Abstract: Mobile smart devices are gaining popularity rapidly. These digital devices facilitate a new generation of technological tools that offer unprecedented access to content as well as opportunities for creative use even for young children. The development of mobile technology and the proliferation of smartphones have made m-Learning and e-Learning one of the most efficient methods of learning. Previous studies have explained the positive impact of using e-library mobile applications to develop literacy skills of children. Despite positive outcomes, Sri Lanka does not have an e-library mobile application for children to improve their reading and writing skills in both Sinhala and English. A solution to overcome this problem is to develop an e-library mobile application for kids. Story Catcher e-library mobile application contains books, poems, and songs in both Sinhala and English languages with the special narrating feature which helps kids to learn correct pronunciation and to improve verbal fluency, and communication skills. Special features like a screen time management option for parental control and to avoid overuse, an interactive game for the kids and an option to add or remove any book, song and poem from favourites are included in this mobile application. This research paper proposes a novel method to improve the literacy skills of kids in Sri Lanka.

Keywords: Kids e-library, Android Development, literacy Skills, , Child-Computer Interaction.

1. Introduction

Mobile devices and technology have been rapidly developing in the past few years. As a result of this growth in technology mobile phones are a very common sight in today's society and have made life much easier. The technology advancement has affected the children as well. Children too at a very small age start to use mobile phones, tablets, and other digital devices. These devices have become a part of the children's life and if used properly, it can help them in their development process specially in education. m-Learning and e-Learning has become one of the most efficient methods of learning with the advancement in mobile technology and expansion of smartphone use. People can have access to various content and productivity tools by just a few clicks. This has made learning, reading, and writing easy and simple.

There are various e-Library mobile applications that are freely available to download to our smartphone. These e-Library mobile applications are in various languages and grouped into kids, teenagers, adults, and various other categorizations.

According to the literature review conducted, there is no existing e-Library mobile application for kids with both Sinhala and English material. This paper covers, a mobile application named "Story Catcher" consisting of books, poems, and songs in both English and Sinhala languages. The intended users are kids below the age of 8.

Reading is very important for a growing child to develop early literacy skills. This mobile application provides the opportunity to develop the reading and listening skill. With the text and narrative feature, a child's pronunciation, verbal fluency, and communication skills can be developed. The inclusion of poems and songs in the application is another way of helping the child's language and literacy development. Singing songs and reciting poems are great activities to boost a child's imagination and stimulate curiosity. Having bilingual material will allow the child to experience a cultural background and learn two languages.

The mentioned mobile application will help kids with special needs as well. The narrative feature helps to reduce frustration if the child does not know how to pronounce a particular word. Kids increase their sight word recognition once the correct pronunciation is heard (Schanck and Waller, 2013).

Due to the busy lifestyle that exists today, parents are unable to direct their children to read books. At this playful age, children are less interested in reading and show more interest in using digital devices to watch animated cartoons. So, we can see this as an opportunity to use technology to guide children to read.

Today, children are in touch with new technology. One of the common problems is that they spend excessive amount of time using these devices because of not having the screen time feature in most of the mobile applications.
As a solution for the mentioned problems the proposed, safe digital media platform named 'Story Catcher' e-library for kids is a unique solution.

2. Literature Review

E-Library mobile applications are the latest reading platform that provides an online database with a huge collection of books, poems, articles, magazines, etc. While e-Books have been around for many years, recent improvements in the adaptability and affordability of smartphones, tablets, and other digital devices along with increased access to the internet have led to a dramatic increase in the use of e-Books. According to research by Irene Picton on "The Impact of eBooks on Reading Motivation and Reading Skills of Children and Young People", 53% of children use digital devices to read books (Picton, 2014).

"Story Catcher e-Library" is designed for kids below age of 8. Due to the age factor, the design of the interface and user-friendliness of the application are necessary aspects to consider. The research paper "Developing Mobile Applications or Children" it states that Rose Kivi writes "the colours red, orange and yellow simulate and increase brain activity and the colours green, blue and violet induce relaxation". Rose Kivi also states that a comfortable feeling can be induced using warm colours, while bright colours create a feeling of excitement (Wängberg, 2012).

Here are some of the existing kids e-Library applications:
"Epic" is one of the leading digital reading platforms for kids 12 and under. This application offers access to more than 40,000 English books, learning videos, and reading quizzes for kids. With "Epic", the parent can track the child's reading progress as well as the time spent reading. 'Epic' for home and 'Epic' for educators are the two versions available through the app. The downside of it is that this application does not provide an interactive learning experience for kids (quizzes, games). "Epic" users can try the free version prior to purchasing the full application. "Epic" is available for both Apple iOS and Android platform (Epic,2021).

"Little Stories" is another mobile application for kids 8 and under. This application consists of 1000+ pictures, 21 exciting bedtime English fairy tales for toddlers. By using this application, parent or the kid can create audiobooks by recording their own voice but does not provide the user with pre-recorded audiobooks. "Little Stories" mobile application users can try the application for free prior to purchasing the full app. This application is available for both Apple iOS and Android platform (Little Stories Bedtime books,2021).

"Smart Kidz Club" for kids and toddlers is an exclusive library of English audiobooks, read to me e-Books, flashcards, learning games for kids 2-11 years old. The application motivates kids with awarding badges,

encourages kids with rewards and challenges kids with a leaderboard. "Smart Kidz Club" application is available for both Android and iOS users (SmartKidzClub,2021).

"Lama Katha" is a kids e-Library mobile application which only includes books in the Sinhala language. This application consists of Children's stories and Jana Katha. There are no audiobooks included in this application. "Lama Katha" is only available for mobile devices that run on the Android platform (LamaKatha,2021).

"Let's read" mobile application consists of books that are 100% free to read. Favourite books are free to download and save for reading at any time, online, or offline. Multilingual readers can switch between languages within the storybooks with a quick tap, accessing the many languages available on the Let's Read app, including English. "Let's read" is only available for mobile devices that run on the Android platform (LetsRead,2021).

"Vooks" application transport stories off the page, promoting literacy, imagination, and fun for children 2 - 8 years old. This mobile application is a kid safe, ad-free streaming library of read aloud animated English storybooks. "Vooks" users can try the free version prior to purchasing the full application. "Vooks" is available for both Apple iOS and Android platform (Vooks,2021).

The purpose of this review was to view the features and trends in kids' e-library mobile applications which have a higher rating in Google Play Store and Apple App Store and are developed within the past few years. It is clear from the research reviewed that the kids' physical and mental well-being takes place a major role when developing kids' mobile applications. When comparing the existing kids' e- library mobile applications and the story catcher mobile application, Story Catcher has been developed with the newest features which were not found in existing mobile applications. Features like screen time and kids safe setting button were not found in any of the existing kids' e-library applications. Story Catcher is the only mobile application that offers books, poems, and songs in both Sinhala and English. A comparison of the game section shows that Story Catcher provides an interactive learning experience for kids through games, whereas Little Stories, Lama Katha, Lets Read, and Vooks do not.

3. Design and Implementation

The system design is an integral part of any successful system. A system's design involves defining its elements such as modules, architecture, components, interfaces, and data based on its specifications.

A. Architectural Design

The architecture design describes the components and specifications required to support the solution and ensure that the design meets the specific business and technical requirements. Simply we can say that architectural design defines the overall structure of the system. The architectural design is given according to the three-tier-architecture. The three-tier architecture splits the overall design in to three layers as presentation tier which is the user interface, application tier where the data is processed and lastly data tier where the data associated with the application is stored and managed.
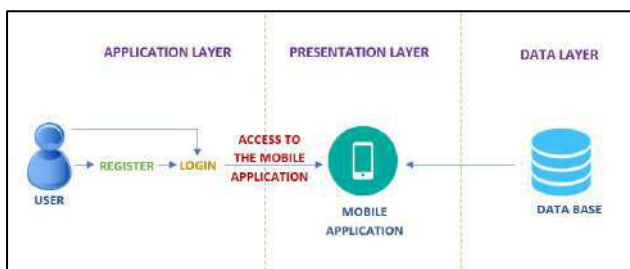

Figure 1. System Architecture

1) Application Tier: This is the heart of the mobile application. In this tier, data collected from the presentation tier is analysed and then can add, delete, or modify data in the data tier. In our system, application tier is developed using Java and communication with the data tier is done using API calls. The application layer connects to the presentation tier and the data tier. Typically, administrator has the ability to control application tier. The information about the kid, parent and the tasks of both parties will be displayed in the application tier. Application layer interacts with both layers therefore changes done in this section affects both presentation and data tiers.

2) Data Tier: The data tier, also known as the database or data access tier, is where the application stores and manages the information processed. This is the section where all the database management applications run. In the "Story Catcher" mobile application, the database used is Firebase database which is a cloud hosted NoSQL database that stores and sync data between users in real time. The user details, books, songs, poems, and games are stored in the Firebase database.

3) Presentation Tier: The presentation tier is the user interface and communication layer of the application, where the end user interacts with the application. In general, it displays information to users and collects information from them. Presentation tier is the only layer that user can see and interacts with. The presentation layer is designed considering the kids' point of view with an attractive user interface and kids friendly user experience. User registration, and the current situation of the requests are happening in this layer. User has the ability to enter details in the presentation layer and the details entered in the presentation layer get delivered to the application layer.

B. Modular Architecture
Using modular architecture when designing the mobile application allows to redo parts without affecting the rest, and it facilitates maintenance by being divided into smaller and lesser complex parts. Each module has a unique responsibility and unique functional behaviour. Below categorized modules can change without affecting each other and can communicate with other modules without knowing them completely.
Module 1: "Login and Register Module"
1.1 User registration
1.2 User login
1.3 Reset password

Module 2: "Library Module"
2.1 Select and read any book, poem, and song in Sinhala or English language.
2.2 Add favourite books, songs, and poems to My library.
2.3 Select text only or read with narration option.
2.4 Search books, poems, and songs
Module 3: "Game Module"
3.1 Play games

Module 4: "Settings Module"
4.1 Setting the screen time
4.2 Change user information
4.3 User logout

C. Data Design
The data design helps to manage the data storage and database operations of the system. To store data and information of the mobile applications, Firebase is used as the database. The user details, books, poems, and songs are stored in the Firebase database. Firebase allows to store and sync data in real-time.

D. Interface Design
The graphical user interface of the Story Catcher mobile application is where all functionalities are grouped visually and logically into thematic unit. The user interface is a crucial aspect of the system in terms of what the client wants and needs. Keep the interface simple, create consistency and use common user interface elements and strategically use colour and texture are some of the best practices for designing an interface.

A Splash Screen appears when the application is launched, the splash screen consists of the application logo. For kids and parents to get an immediate positive impression about the application, the logo of the application is designed.

When designing the mobile application, the important factors to consider are easy navigation and fast fill out, as

Figure 2. Application Interfaces

users could get frustrated by the complexity of the application. Minimalistic approach when designing the buttons and other elements so that the application looks clean, and user can easily access the application. The typeface is not in cursive or italics since those are difficult to read. Using different shapes in different screens like circles, ovels, squares etc. to invoke user's creative mind. As small children do not know how to read so they rely on symbols mostly. The icons used are very simple and easily understandable.

Colours play a special role in evoking powerful emotions in humans. For the interfaces, colours that induce feelings and emotions to the user are used. The colours are used such that the background and icons become more contrasted. Additionally, the colours are gender neutral colours that induces relaxation and helps to focus creating a learning environment for the kids. The background images in certain screen have reduced opacity so that it will not disturb the main content.

The settings are meant for the parent, so it is placed away from the main section of the screen, making it less likely to be pressed by accident. The Settings icon does not stand out as much from the surrounding. When it is double tapped, the first tap will change the colour and make it clearly visible, and the second tap will change interface to the Settings layout.

E. System Requirements

Story Catcher is an Android mobile application, so it is necessary to have a mobile with Android OS. The minimum specification to run the application smoothly is as follows:

- RAM 3GB
- Android version- 4.2 Jelly Bean
- Chipset- Snapdragon 410
- CPU- Quadcore 1.2 GHz
- 5'' touch screen display
- 500 mb free memory space
- Internet connection

4. Technology Adopted

New technological approaches emerge every day. Appropriate development environment is necessary to

develop a successful mobile application. When selecting these technologies, it is necessary explore and study the features, benefits, and limitations of the available technologies and select which is most appropriate for the fulfilment of tasks relevant to the project's nature and requirements. The following technologies and platforms were used to accomplish this: Android Studio, Figma, Adobe Photoshop, and Firebase.

Figma is a collaborative interface tool which is used to design user interfaces of an application or system. Designing the user interfaces and getting an idea of the layout was done using Figma. The Figma Mirror feature allows to view the design in our mobile and get a hands-on experience on how the designed user interface will look in a mobile.

Android Studio is the official integrated development environment for Google's Android operating system

designed specifically for Android development. As Android Studio is also considered as stable IDE and development is faster in Android Studio as it is specifically designed to accelerate the process of Android mobile application development. A highly integrated Gradle build system is used in Android Studio, this tool offers dependency management which helps to enhance the developer experience because its more extensible

Firebase database was used as the database for the mobile application. Firebase database is a cloud hosted NoSQL database that let the user store and sync data in real-time. The Firebase Cloud Firestore database type is used in this application since Cloud Firestore is more permissive in term of queries.

Adobe photoshop is a photo editing and manipulating software which is used for design purposes. In the process of designing the "Story Catcher" mobile application Adobe Photoshop was used to edit images, design wordings and match colours. In designing minor elements of the interface, Adobe Photoshop's vast array of tools and options are of great help.

5. Results and Discussion

The "Story Catcher" e-library mobile application is an age-appropriate mobile application specially designed for kids. According to the research and survey carried out, the shortcomings in existing kids e-library mobile applications were identified and the issues faced by parents by letting the kids use these applications. The unavailability of fruitful content for kids in these existing mobile applications is a problem. With today's busy schedule, parents have less time to read to their kids and using e-library mobile applications from the e-library is a good solution for this. However, allowing kids to use digital devices raises the concerns of addiction and overuse.

According to these problems identified, and as a solution the "Story Catcher" e library mobile application is developed to reduce these problems. A screen time feature is included in the mobile application. The main reason for adding this option is to avoid the kid from overusing the application and avoid addiction for the smart digital devices. The screen time feature allows parents to set a time for their children to use the application and when the timer runs out, the application closes automatically. We have added screen time up to 40 minutes with the option of selecting 6-time limits (15 minutes, 20 minutes, 25 minutes, 30 minutes, 35 minutes, and 40 minutes).

The "Story Catcher" e-library mobile application consists of books, songs and poems in both Sinhala and English languages. Providing the opportunity for kids to spend a fun and educative time in a learning environment. The inclusion of bilingual material will give the child to experience cultural background and learn two languages.

In the "Story Catcher" mobile application, the opportunity to choose between the read only option and read with narration option is available. The read with narration helps the child in pronunciation, listening skill, imagination, verbal fluency, and communication skills. The read only option will also help the kid in sight word recognition, boost the kid's imagination, improves brain connectivity, verbal fluency and helps in early literacy skills.

The "My Library" feature is another important feature in the application. This feature enables the kids to add their favourites to their "My Library". By directly going to the "My Library" screen the kid can access their favourites without having to use the search option or going through the full library in search of one specific item. Removal of what has been added to the "My Library" is also possible.

The search option makes the e-Library mobile application more user friendly and effective system. The user can enter the title of what they want to search and play it from there without having to go through the full library in search one specific item.

6. Conclusion and Future Work

A. Conclusion

The "Story Catcher" e-Library mobile application provides kids with a wide range of books, poems, and songs in both English and Sinhala Languages. Providing the users with a seamless user experience and kid friendly learning environment. Improving a child's imagination and cognitive development, as well as their early language and literacy development, is among the points that will help our users with our mobile application. "Story Catcher" is an age-appropriate kid friendly e-Library mobile application that enables the parent to set a screen time and avoid the kid from overusing the mobile application.

When considering a mobile application, it is required to develop furthermore, update and add new features to it. If not the user's interest towards the application tends to reduce. With growing technologies and introducing new trends to the market, it is a must to update a kid's mobile application like "Story Catcher".

The current mobile application supports only the Android operating system. Develop an Apple IOS-compatible mobile application as a future enhancement. By using frameworks like React Native and Flutter, the mobile application can be developed so that it is compatible with both IOS and Android OS.

It is an added benefit for the user and development team when an Artificial Intelligence (AI) feature is added to a mobile application. Adding a content recommendation feature to the mobile application so kids can access more content based on their preferences. Machine Learning is a branch of AI. By applying the concepts of machine learning such as Artificial Neural Network (ANN) and Deep Learning the content recommendation feature can be developed in the future. This feature will provide a better user experience and will help the development team when adding new content to the database.

Algolia is an AI-driven search and discovery platform that enables to create cutting-edge customer experiences for mobile applications. With the growth of the mobile application and increasing content, an AI-driven search API will provide a better search function and make it easier for users to find what they are looking for by just entering a few keywords. The Algolia API is available only for the Firebase "Blaze" which is a pay as you go plan. The current mobile application uses the Firebase "Spark" which is a free plan. With the growth users, an upgrade to the "Blaze" plan is possible. The Algolia search function can then be added as a future enhancement to the mobile application to enhance the user-friendliness of the mobile application.

An offline mode where the user can play any book, poem, or book that has been downloaded can be included as an additional future work. Voice search function so that the user voice out a keyword or title of what they want to search, and the voice search function will take over from there onwards. This feature too is to be added in the future. A monthly subscription fee will be charged from the registered users. The first month will be free, but once the month is over the user must pay their subscription fee. Secure payment gateways will be implemented to ensure the security and confidentiality of subscribed users. This too is a future enhancement.

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Identify the usage level of ICT-based Knowledge Management Systems (IKMS) among vegetable farmers in Sri Lanka

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Abstract*: Information and communication technologies significantly bridge the information gap within communities towards creating a knowledge economy. Agriculture in Sri Lanka is one such sector that can derive benefits by providing the correct information at the right time to make actionable decisions. The use of information during the crop life cycle helps farmers eliminate most of the daily issues. Information on cultivation methods, price fluctuations, supply, and demand is essential for farmers to make the right choices and get a better income. Having identified the essence of information and communication systems in bridging the information gap in farming communities, many mobile-based information systems have been introduced to the agriculture sector of Sri Lanka. We conducted a survey to understand how widespread these information systems among the farmer communities were and consequently found out that the use of such systems is very low among farmers. This survey was conducted among 54 farmers covering the major agriculture zones in Sri Lanka and revealed that only 63% were aware of the available systems. In contrast, only 35% of the farmers use these applications to obtain information. Around 37% were unaware of the existence of applications though smartphone usage is recorded to be about 85%. This paper highlights the reasons for the lack of digital information systems usage among the farming community in Sri Lanka. Furthermore, the paper will pave the path by highlighting the initiatives that can be carried out to increase the use and thus contribute toward a knowledge economy.*

Keywords*: ICT-Based Knowledge Management Systems, Knowledge Economy, Technology Acceptance Model*

1. Introduction

The use of ICT in agriculture sector is very low among the farmer communities as well as agricultural organizations (Jayathilake et al., 2015). ICT related technologies can be used as a strategic tool to improve the agriculture sector in Sri Lanka. Maximum utilization of ICT can be obtaining via increase the adoption of ICT, promoting ICT tool and creating the awareness among communities. Use of proper ICT application will support stakeholders of agriculture sector in Sri Lanka to access correct and accurate information which can be positively influence the growth of agriculture sector in many aspects. Mahindarathne (2022) described that use of ICT related technologies in agriculture sector as at today in a range of make a simple mobile phone call to obtain some details regarding the market information to high-tech practises such as "mobile-mediated agricultural information systems, e-agriculture, m-agriculture, cyber extension, precision agriculture through informatics of cultivation, and mechatronics technologies and agriculture resource planning via global positioning systems (GPS) and global information systems (GIS)". Information and communication technology has become the facilitator and platform of the agricultural sector, enabling field connectivity as well as precision. Mahindarathne (2022) mentioned further that, given the pace and desire to revolutionize the ICT sector; the opportunities for agriculture to benefit from ICT are enormous and exciting.

Sri Lanka's telecommunications sector has undergone dramatic transformation since 1977, passing several substantial milestones. As a result, Sri Lanka has made significant progress in ICT infrastructure as well as ICT literacy level during past few years. Some of the applications introduced by department of agriculture in Sri Lanka for agriculture sector are; "use of IMM CD-ROMs as crop-based information materials (2004), cyber extension (2004), a farmers' database for e-marketing, the Toll-Free Agriculture Advisory Service (2004), and the Cyber Agriculture 'WikiGoviya' website (2013)". Apart from that, Ministry of agriculture- Mobitel (pvt) Ltd introduced "Mobitel Agri-price Index 6666" to access latest market prices details for farmers. The "Dialog TradeNet agri-price service" is another establishment done by "Dialog Axiata" and it also provides market price details (Mahindarathne, 2022), (Ekanayake and Sirisuriya, 2016).There are several web sites such as www.pmb.lk introduced by "Sri Lanka paddy marketing board" and www.goviya.lk of DOA to obtain crop

related information required by farmers in Sri Lanka (Ekanayake and Sirisuriya, 2016). Baddegamage et al. (2022) mentioned that Govinana is a system introduced for Sri Lankan farmers to access market place without much issue.

Information systems provide accurate and timely information to farmers, but most of Sri Lankan farmers are reluctant to use ICT based Information Systems (IS) for many reasons. Farmers are expecting comprehensive and updated information via available ICT based information systems. The internet based information system developed and established by "Sri Lanka Paddy Marketing Board" is not using by farmers due to lack of awareness and low ICT literacy, issues with infrastructure and signal, non-user friendliness and complexity of the system (Ekanayake and Sirisuriya, 2016). There are various types of Apps have been developed by many government and non-government organization for use of the agriculture sector in Sri Lanka. Apps such as Govipola, Badumila and Welandapola provide direct access of the market places and buyers for farmers. These Apps facilitate to skip intermediates and link farmers directly with buyers. But said applications have reported very little use by farmers (Sandareka et al., 2020).

2. Research Question

Proper use of Information Management (IM) with the support of ICT can help farmers to overcome issues in the sector. ICT based IM systems must be equip with valid up to date data and it is required to continuously use the IS to have adequate data to provide proper information. Knowledge in an essential factor in agriculture and information required to build up the knowledge. Knowledge can be used as a tool to solve issues in the agriculture and there are many information management systems available create required knowledge. Since farmers do not interested to use available ISs and lack of awareness, information systems have become obsolete during shorter period, IS can't support farmers, farmers can't obtain assistance from ISs and issues in the field used to continue as usually.

The research question investigate in this research is What is the usage level of ICT-based Knowledge Management Systems (IKMS) among vegetable farmers in Sri Lanka?.

3. Literature Review

Vegetable farmers in Sri Lanka are reluctant to make the right decisions at the right time as they do not have the correct information obtained by accessing the right information channels. They do not use available information systems for agriculture sector. Underutilization of available information channels and in-proper decisions taken by farmers cause to escalation of demand-less vegetables and

get wasted at market places or farm lands (Sivagnanasundaram et al., 2018). As a result, farmers are facing financial losses as well as a number of socio-economic problems (Baddegamage et al., 2022). Ginige et al. (2016) also have mentioned that "incorrect crop selections, lack of professional advice, technologies, seeds, best practices and proper agricultural knowledge" are the some of the reason for losses and frustrations in the agriculture sector of Sri Lanka. Root causes for above reasons have been identified as monetary concerns, difficulties of proper marketing campaigns, transport and delivery related issues, cultural and social norms, Difficulty in reaching due to distant and remote areas as well as ICT literacy and poor language abilities (Sivagnanasundaram et al., 2018).

Sivagnanasundaram et al., (2019) have identified that the knowledge gap among vegetable growers and researchers is significant. It is in the national interest to establish a mechanism to impart to farmers the knowledge gained through research and development conducted by universities and other research institutes. Although the essential link between research institutes-universities and the agro-industries are not present in Sri Lanka, it remains strong in developed countries. Developed countries see research and development as an investment for the future and they benefit the most.

Developed countries are heavily using advance technologies to increase agricultural production. Use of "fast-growing genetically modified crops", use of Artificial Intelligent (AI) to minimise cost and improve productivity, use of "Microbiomes and biopesticides" to protect crops from pest and diseases, use of RNAi (Ribonucleic acid interference) which plants can be programmed for growth and survival, practice of "block-chain technology" to manage information regarding all the stages of production of the agro- products, "Hydroponic farms", use of packing which can be consumed(Edible Packing), use of satellite have direct access to weather related information, use of meat cultivation technologies(Tube Meat) and robotics are most commonly used technologies in Europe and UAS. All the above technologies use high tech knowledge-oriented systems. These countries expect food security and sustainable development in the agriculture sector by establishing such technologies in their countries (Kuvaeva et al., 2019). It shows that economies need to be transformed into "knowledge-based" economies, and that the use of technology is essential in this direction.

There is no problem of lack of information required for the agricultural sector in Sri Lanka. The issue is with the utilization of available information. In 2019, 11 information

systems were developed and implemented, but farmers did not know much about this initiative. The hotline number of DOA knew only 33% of vegetable farmers and 12 % farmers knew about Hector Kobbakaduwa Agrarian Research and Training Institute (HARTI) hotline of market information centre. Only 3-4% of farmers were aware about "Govi Mithuru App", "Krushi FM Web Radio" and "Govipola app". Awareness regarding other available Apps was reported much lesser than 3%. Around 65% of farmers had issues in accessing information systems since they have only land phone or non-smart mobile phones. Farmers with ability to access information system were reported as 30%. There is an in-balance in the agriculture sector about the availability of tools to access information systems, ability of accessing and willingness of use information systems in the agriculture sector in Sri Lanka (Wijesinghe et al., 2021).

The cost of accessing information via ICT application is very high in Sri Lanka. Difficulties in obtaining information due to cost have obstructed the use of information and communication technology in the agricultural sector of the country (Jayathilake et al., 2015). Lack of infrastructure facilities, non-availability of training, poor research and development, lack of skills, issues due to social and political norms are also have become barriers for farmers to access ICT related technologies in Sri Lanka (Narmilan et al., 2020). Correspondingly, Subashini and Fernando (2017) have stated that the poor ICT literacy is one of the main issues for ICT adoption in the agriculture sector in Sri Lanka. Furthermore, difficulties of using English language as well as the cost of ICT equipment also prevent farmer from using ICT enabled technologies (Sandareka and Wedasinghe, 2017). According to Baddegamage et al. (2021), "cost of technology, lower trust regarding systems, no training, infrastructure issues, non-availability of support services resistance and limitations of adoption to new technologies" are encountered as obligations for use and adoption of ICT based information systems among Sri Lankan farmers. Premarathna (2018) also mentioned that "knowledge lack, training issues, problems related to language and unawareness about benefits" are some of the reasons to not to use ICT based applications by farmers in Sri Lanka. Not only that, complexities of the agriculture sector, low level of external supports, lack of real farming experiences, issues of infrastructure facilities, availability of information, farmer strength to accept and adopt into new technologies, farmer's wiliness of absorb new stuffs, training related issues, issues in system integration as well as software non-availability also encountered as factors which are prevent farmers access from ICT based information systems in Sri Lanka (Ekanayake, and Sirisuriya, 2016).

As per Wijerathna et al. (2020), there are some problems of receiving up-to-date information for government owned information centres in Sri Lanka. Some of the government officers are not capable of providing their information services for farmers up to the expectations. The bureaucratic nature of public officials and their political as well as social background are the reasons behind these unacceptable behaviours. Poor coordination among farmers, buyers and markets, as well as technical concerns such as unavailability of systems, also block farmers' access to ICT based agriculture information systems in Sri Lanka. Finally, due to factors such as poor knowledge and non-awareness, difficulties in accessing, complexity of systems, language barriers farmers do not have access to ICT based information systems available in the agricultural sector in Sri Lanka (Sandareka and Wedasinghe, 2017).

4. Methodology

The objective of the research is to identify the usage level of ICT-based Knowledge Management Systems (IKMS) among farmers in Sri Lanka. According to the literature review, it has been shown that the use of IKMS among farmers' communities in Sri Lanka is very low and some farmers are not aware of the existence of such support systems.This research has been conducted to identify the current status of utilization level of vegetable farmers in Sri Lanka. As ICT systems have become a common practice in the daily lives of the common people and the pandemic and lockdown conditions have increased the use of online systems among communities, it is worth investigating the current level of use of IKMS in the vegetable agriculture sector in Sri Lanka.

The research started in September 2022 and was unable to reach farmers communities in the country due to the lockdown and travel restrictions imposed during the COVID-19 pandemic. Due to these constraints, a 27-question Google Form-based questionnaire was created and distributed through social media.

The questions created in the Google Form focused mainly on awareness of the existence of IKMS, use of IKMS, user expectations, reasons for non-use, and infrastructure availability(accessibility).

The Google form was distributed among Facebook farmers' groups and WhatsApp groups. The language used in the Google model was Sinhala as the target community is very comfortable with this language. It sent via e-mail using personel contacts . By the 2nd week of December, it had received 66 responses and 42 responses from non-farmer categories.

As per the request, agricultural advisers in Kehelbaddara, Udugampola, Makevita and Malwatu - Hiripitiga provided contact details of farmers registered with the Department of Agriculture. All these farmers are from Gampaha district and 30 responses were obtained through telephone interviews. Forty-two (42) responses had to be omitted due to inapplicability during the data screening and validation process. 54 responses remained for analysis. As the data set was not so complex, it used Microsoft excel for analysis.

5. Data Analysis

Since the main objective of the research identified as "Identify the usage level of ICT-based Knowledge Management Systems (IKMS) among farmers in Sri Lanka", responds received from farmers for the question (Q8) "Do you know that there are computer/mobile phone information systems that provide agricultural information for farming activities?"

Yes : 34   No : 20

Awareness percentage was 62.9% and 37.03% of farmers were not know that there are such systems in Sri Lanka.

The next major issue was related to the amount of system usage. It is only from farmers who say "Yes" to Q8 in the questionnaire. The question (Q10) "Do you use computer/mobile information systems that provide agricultural information for farming activities?" received responds as follows:

Yes : 19   No : 15

Since the data set was 54, it indicated that 35 farmers out of 54 are not using any information system for their farming activities. It is 64.8% as a percentage and according to the current level of ICT use in the society; it is not a satisfactory figure.

There were several reasons mentioned by farmers as not to use information systems. Details of farmers' responds appeared in table 1.

Table 1. Reasons for not to use Information Systems

Reason for not to use Information Systems	Count
No computer or smart phone	1
Does not know how to use a computer or smart phone	1
Lack of confidence in computerized information systems that provide information	2
I don't understand what is written in English	1
Those information systems are very complex	1
Dislikes the use of technical tools	1
The use of technical tools cannot be taught	1
There is no time to use technical tools	1
The benefits of computer/mobile information systems that provide agricultural information are not known.	1

Data costs a lot	1
The internet connection in our province is not sufficient for the use of information systems	1

According to the responses received for Q10, there are 19 users of information systems. The next important question given to those 19 users was (Q14), which asked "Are you satisfied with the services provided by the information systems you use?". Responds received as follows:

Yes: 12 No: 7

There were 12 satisfied users and 7 non satisfied users. The percentage of non-satisfied users was 36.8%. Reasons for non-satisfaction have mention as per the table 2.

Table 2. Reasons for Non-Satisfaction

Reason for Non-Satisfaction	Count
The information displayed is incorrect	3
No new information (no updates)	9
No required information	7
The available information is incomprehensible	1
Handling is very complex	1
Difficult to learn how to use	3
It is difficult to use because the mother tongue is not used	1
No accessories/facilities required	0
It consumes a lot of data	1
The internet connection in our province is not sufficient for the use of information systems	1

6. Discussion

The data analysis limited to responds received for 02 selected main questions out of 27 questions in the questionnaire. As per the results, 37.03 % of farmers are not aware about the existence of agricultural information systems in Sri Lanka. 33.2% of farmers in the sample actually use existing information systems, which is also very low use. Given this situation, moving to a knowledge-based economy will be an extremely challenging task as the use of IKMS is a key requirement of such an economy. Reasons given for not to use information systems are almost equally effective. "No new information" and "No required information" are very important for dissatisfaction with system usage.

7. Conclusion, Recommendation and Further Research

Sri Lankan farmers have different types of information systems to obtain necessary information within the crop cycle, but the use of the existing information systems are very low among farmer communities. Low use of the information systems make IS incomplete, non-comprehensive, low informative and low lifetime. It is required to use the information systems continuously to become a knowledge base. Use of knowledge gained with proper information will help to manage mentioned issues in the agriculture sector of Sri Lanka. The 'knowledge driven agriculture' can be used as the driving force for solving most of the issues in Sri Lankan agriculture sector and that has been proved in many other similar economies as well as developed countries. The main obstacles of implementing such "knowledge driven agriculture" in Sri Lanka are low use and resistance to accept ICT based information systems among farmers. There should be an acceptable attraction for farmers to use information systems continuously. It is recommended to identify factors can influence to increase the usage of ICT systems among farmers in Sri Lanka. As the next step of the research, it recommended to research with a large population to identify how to motivate formers to use IKISs in Sri Lanka.

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Abbreviations and Specific Symbols

ICT: Information Communication Technology IKMS: ICT-Based Knowledge Management Systems

GPS: Global Positioning Systems

IS: Information Systems

IM: Information Management

AI: Artificial Intelligent

RNAi: Ribonucleic acid interference

HARTI: Hector Kobbakaduwa Agrarian Research and Training Institute

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VehiPark- Online Vehicle Parking Management System

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Abstract*:Traffic congestion is exacerbated by the parking issue. The proposed vehicle parking system is built with Android (Mobile) and Web Applications. Android (Mobile) application for car owners to book their parking space and Web application for park owners to design their park and easily update park information. In addition, our project's goal will be outlined. The project's goals and constraints will be discussed at the conclusion of this chapter. Traditional methods of arranging a car slot do not appear to be more efficient. Many human resources are required to keep track of the details of the individual who reserved the parking space. The primary goal of this project is to create a new smart parking system that assists vehicles in identifying parking slots in a specific parking area. For this paper's data collection methods, document analysis and questionnaires were used. The current technique is time-consuming and generates gridlock when there is no proper and simple system in place to govern parking spaces. This proposed system would allow consumers to book a car slot before arriving at their selected location. This system results in functions such as displaying available parking spaces, accepting money for parking spaces, and legally accepting booking a slot.*

Keywords*:Android, Web development, Mobile computing, Vehicle parking*

1. Introduction

From the past, the matter is existing. The population is being increased day by day and the number of vehicles. Most of the time, there is no parking spot for the vehicle and there is no better way to have a parking spot when after arriving at a place. Most of the methods that are available nowadays, for booking a vehicle slot don't seem to be more efficient or user friendly. At the parking areas, vehicle owners must seem for a parking spot by drive their vehicle over the parking area. The problem with this traditional method is that it's more time consuming hence less efficient. The entire concept is hectic as vehicle drivers park their vehicle on the roadside. This leads to a traffic jam or congestion.

The current Silicon age world tends to change from manual and local Vehicle Parking Reservation System to computerized and Online Vehicle Parking Reservation system to make management, registration, and booking easier. This has helped to minimize paperwork, errors made by the reservation office like miss spelling the number plate, vehicle model, time wastage, delays, and congestion at the reservation office.

After a detailed significant study of the existing systems. It is found through a thorough study of the currents existing found from different parts of the world that these systems are composed of more hardware components which adds an extra budget to the system and requires high maintenance since these hardware components used are more likely to break down. Usage of many hardware components requires a considerable power supply therefore it is an evident need to make sure there is a continuous power supply, which adds to the budget.

Referred the existing systems and mentioned the issues with that. Then found a better practical solution with current technologies that we can establish. We can provide better and easy-to-use experience to the user and service providers by connecting them through our project. Therefore, it enables the best procedure to reserve a parking slot early rather than waiting in the queue. It is the newest experience with some new features to anyone using our system.

We have studied deeply on eight research papers on existing systems (two papers for each member) to get a clear understanding to improve our new system way better than those existing systems. We studied research papers not only international research papers but also local research papers.

2. Literature Review

The new system develops a Mobile application for vehicle users and the web application for the admin to establish possible solutions to improve the current Vehicle Parking Reservation problems and limitations as mentioned above in current systems. The new system is a combination of a mobile application and a web application the mobile application is specifically for vehicle users, and a web application is designed for park owners.

"Smart Car Parking Management System" This system proposed the following methods: Develop an intelligent car parking system to solve the chaos, perplexity and long queues at the entry and exit of a parking space located inside public buildings, including shopping malls and office spaces. Research problem or question: In recent years, a massive number of newly registered vehicles have been added to the congested cities of Bangladesh. This means registered vehicles are increasing, but car parking facilities are deemed inadequate to sustain the influx of vehicles on the road. Unplanned parking is one of the leading causes of traffic jams in a city. Thus, traffic congestion can be significantly attenuated by utilizing these confined parking spaces (Ball and Byahatti, 2016).

"Eco QR Car Park System" This system proposed the following methods:

To minimize the parking system cost, reduce the environment's pollution, and improve the customer's overall satisfaction. Limitations of this system can be listed as follows, With the use of QR codes following disadvantages can be obtained, Lack of Familiarity, Slower, Security issues (Jogada and Warad, 2016). With the use of bar codes following disadvantages can be obtained, slightly more difficult to read or scan, needs to be near the scanner, can't add additional information, not very secure, vulnerable. With the use of RFID following disadvantages can be obtained, more expensive, picking up information problem, tag collision problem (Siew et al., 2016).

"Smart Car Parking Slot Reservation Using Mobile Application" Research problem or question: the problem of inessential time consumption in finding parking space in college campus car park areas. This system proposed the following methods:
- Mobile Application Development.
- Interfacing GSM with Microcontroller.
- Interfacing RFID Module with Microcontroller.
- Interfacing LCD with Microcontroller (Wang & Long, 2018).

Limitations of this system can be listed as follows,
- The use of redundant systems will result in a more significant cost.
- It may be confusing for unfamiliar users.
- It is not recommended for high peak-hour volume facilities (Chowdhury et al., 2019).

"A Smart Vehicle Parking Management Solution" Research problem or question: The proposed model has been analysed through financial, technical, and operational perspectives. Difficulties in finding vacant spaces,

improper parking, and poor management are some parking lot problems (Rahman, 2020).
This system proposed the following methods:
- RFID-Based Automatic Vehicle Parking System.
- Street Parking System (SPS) based on wireless sensor networks.
- Ultrasonic Sensor Detection Area.
- Vehicle number plate recognition (James & Abraham, 2018).

Limitations of this system can be listed as follows,
Infrared sensors: It supports lower data rate transmission compared to wired transmission. It can control only one device at one time (Ggyu, Gunasekara and Kathriarachchi, 2015).

3. Design and Implementation

It is presumed that the reader has read the proposal since this document also defines the implementation details of the expected behavior given the requirements within it. In the Overall system architecture, it is described about the presentation layer, application layer and the data link layer of the developing system with the aid of diagram.

A. Overall System Architecture
Architectural design defines the overall structure of the system. This forms a solution before moving on to the detail design. The architectural design is given according to the three-tier-architecture where overall design is split in to three layers of presentation tier, application tier and data tier.

B. Software Architecture
Software architecture was based on modularized approach where the software is divided into parts. Each module is assigned to execute one or more tasks of the overall system to achieve the ultimate objectives expected. This section will describe about the organization of the modules it consists of. The overall software system has been divided into several modules.
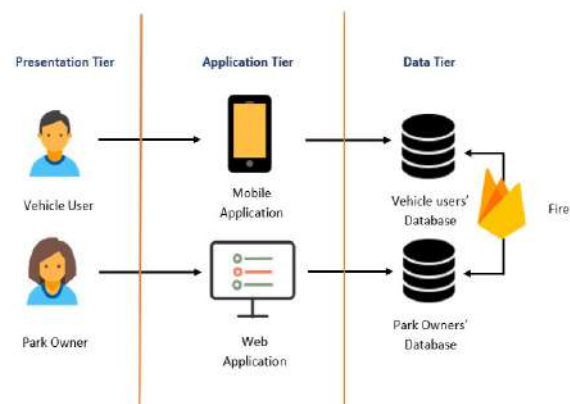

Figure 1: Software Architecture

C. Procedural Design

The objective of procedural design is to transform structural components into a procedural description of the software. The step comes after the data and program structures have been established. Procedural details can be represented in the following ways:

- Graphical Design Notation
- Tabular Design Notation
- Program Design Language

Graphical Design Notation is the most widely used notation. This can be done with flowcharts. In tabular Design Notation, Decision tables provide a notation that translates actions and conditions into a tabular form.

In our project VehiPark, there are two applications for two types of users.

1) The vehicle owners: Regarding vehicle owners, there is a mobile application. The vehicle owners can register to the mobile app and book a parking spot as their preference by selecting a slot from VehiPark.

2) The vehicle park owner: Regarding vehicle park owners, there is a web application. The vehicle park owners can register to the web application and design their park as they want. There, they have to enter the details like numbers of floors, number of bike slots and number of car slots.

We carry out the analysis, design, development, and testing portions one at a time, going back to the earlier ones and implementing adjustments as necessary, to finish our project in thirty weeks. We need the qualities of the Agile paradigm. Agile project management, in contrast to traditional managing projects, is a non-linear approach that prioritizes cooperation, collaboration, and adaptability beyond a specific sequence of events.

In the web application,
1.   The user (vehicle park owner) has to log in or sign up to the web page. If the user has already signed up before, then he can use the login button and log in to the website. Otherwise, the user can sign up first by entering park details.

2.   In the sign up the user must enter the owner's name, park name, address, email, contact number and set a password for their VehiPark account. Then the user can sign up to VehiPark.

If the user hasn't registered to 'VehiPark' before, after signing up he has to design their park.

3.   After the sign-up, the user will have an interface based on their account. There, they have to enter the location of their vehicle park and parking dates like 7 days, weekdays or weekends.
4.   Then next the user has to enter the opening and closing time and payment options they provide to customers to pay for the tickets.
5.   Then they have to select the type of their vehicle park whether it is an outdoor vehicle park or an indoor vehicle park and give the number of parking slots they have in their vehicle park. Those parking slots are divided into car slots, bike slots and disable parking slots.

In the mobile application,
1.   The user (the vehicle owner) has to log in or sign up to the mobile app.
2.   If the user has already signed up before, then he can use the login button and log in to the mobile app after entering the email and password. Otherwise, the user has to sign up first by entering his details.
3.   In the signup, the user has to enter the name, address, email, contact number and set a password for their VehiPark account. Then the user can sign up to VehiPark.
4.   After the sign-up, the user will have an interface based on his account. There he must enter the destination where he wants to go and park his vehicle, the time period he would like to book the slot and his vehicle type either car or bike. Then the user directs to select the parking slots.
5.   In the interface where the user has to select a slot, he can select a slot with his preference. He must select a slot and enter the number of that slot. There the user can identify the available and unavailable slots separately (Omae, Shimizu and Fujioka, 2004).

D. Interface Design

Interfaces are design using two different platforms. Android application is design for the vehicle owners and Web application is design for vehicle park owners. Both vehicle user and vehicle park owner can login to the system using their registered username and password. The functions are available according to their category. User can get the specific services thought mobile application.
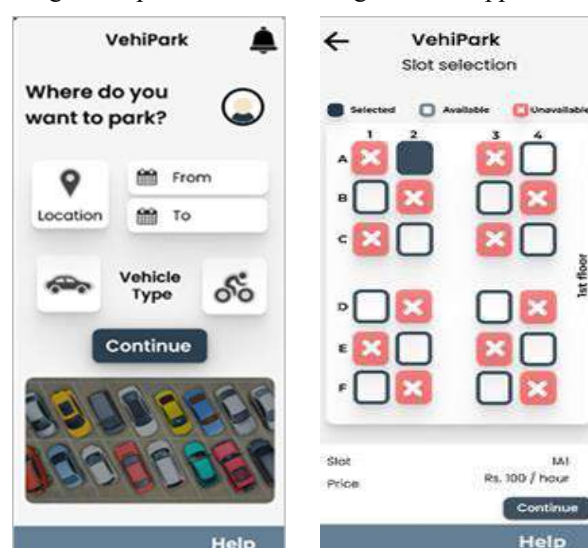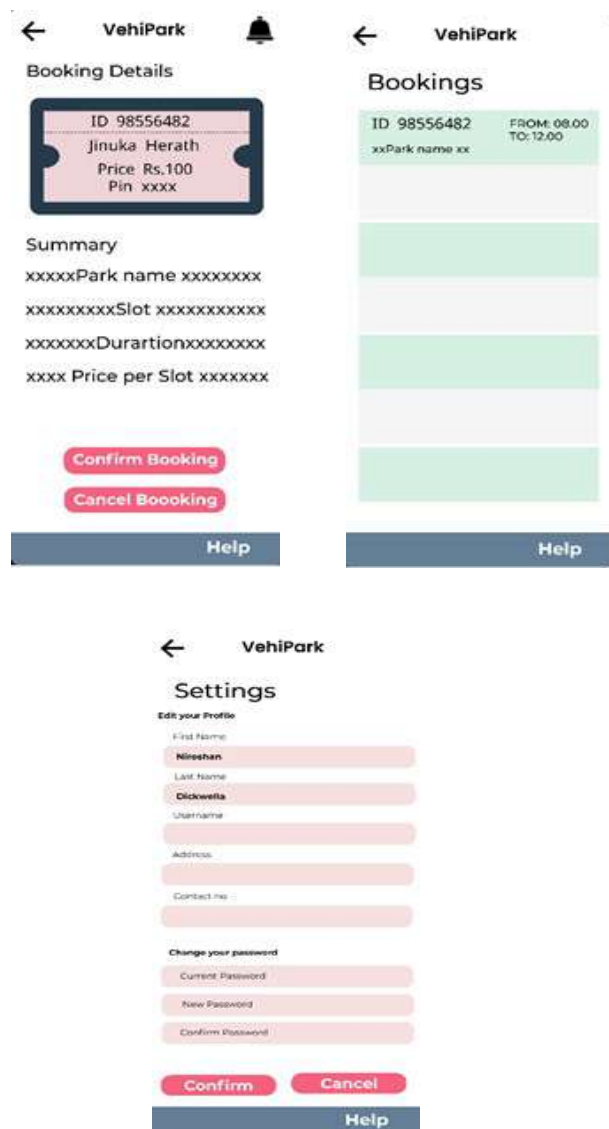
Figure 2: Interfaces of Mobile Application

4. Technology Adopted

A. Android Studio

Android Studio as the Integrated Development Environment (IDE) to create our mobile application. In this project, developers created mobile app using Android Studio. The method of creating apps for smartphones and digital assistants, most notably for Android and iOS, is known as mobile application creation. The apps can include preinstalled, be downloaded from a smartphone app store, or be viewed through a mobile web browser. Android Studio decreases the workload of designing mobile applications for android environment.

B. Firebase Database

Firebse databases to store all data create through the app and added by admins to the system.

C. Java

Java is the main language used for programming android apps. So, we use java to implement the system.

D. Github

Coordinating work among programmers collaboratively and fast performance. In here I should elaborate we implemented the mobile app for android environment while most of other systems were run by using 32- or 64-bit valued windows versions. This will enable everyone to deal with the app in a smart way rather than login to websites. Not only for android users this is eligible run on IOS platforms and can be used in open resources such as Linux.

E. Visual Studio Code

VS Code to implement the web app. There, we used HTML, CSS, and JavaScript. Microsoft software development platforms such as Windows API, Windows Forms, Windows Presentation Foundation, Windows Store and Microsoft Silverlight. It can produce both native code and managed code.

Visual Studio includes a code editor supporting IntelliSense (the code completion component) as well as code refactoring. The integrated debugger works both as a source-level debugger and a machine-level debugger.

5. Results and Discussion

The software was introduced as a solution to the problems caused by lack of parking space, high parking fees and traffic congestion caused by people looking for a place to park. VehiPark is a software application made to manage vehicle parking. VehiPark consisting of a mobile application and a web application. With the web application, park owners can customize their park and with the mobile application, vehicle owners can reserve a space in parks that have registered with the application through the web application. These apps are enhanced with many features for both vehicle owners and park owners.

Apart from the park owner, the individual who will be configuring and registering their park into our online program, the vehicle owner will be able to book their parking place at any time. As a result, testing should be performed from every user's perspective. Several tests must be done to discover faults in the system. Flaws of various forms can arise because of code errors, database connection issues, network issues, and system compatibility issues. Because there are several testing methodologies, it is critical to select testing techniques that are appropriate for the created system, as the objective is to generate a functional mobile application with as few mistakes or problems as possible. The testing methodologies allowed

us to concentrate on one or more elements to reach the desired result.

6. Conclusion and Further Work

The accomplishment of accomplishing the aim depends on the achievement of accomplishing the objectives of the system. So, our project helps vehicle park owners to customize their park and, with the mobile application vehicle owners can reserve a space in parks, which have registered with the application through the web application.

Identifying recommendations is the main phase to provide a user-friendly and user satisfied system in future enhancements. The system called "Vehi Park" which helps the drivers to identify where the vehicle parks are located is already identified, following recommendations about to implement in future development phases.

The existing implemented system will be more productive and efficient with the following implementation.

- Vehicle owners Being able to easily choose the right parking place.
- Park owners can easily customize their vehicle park.
- The ability of one park owner to include more than one park (Phudinawala, Malusare and Mahadik, 2022).

A. Future Enhancement

Identifying major phases will help to implement on future development to provide better experience and expand the achieved scope of the "Vehi Park" vehicle park management system. List of identified major future enhancement phases as follows.

- Taking the vehicle number from the user and detecting the vehicle number to the park and access to enter the park.
- Adding a payment method.
- Allowing park owners to get the statistics of the park.

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Abbreviations and Specific Symbols

- HTML- HyperText Markup Language
- CSS- Cascade Style Sheet
- IDE- Integrated Development Environment
- API- Application Programming Interface
- QR- Quick Response
- GSM- Global System for Mobile Communication
- RFID- Radio-Frequency IDentification
- LCD- Liquid Crystal Display
- SPS – Street Parking System

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Technology Involvement And Effectiveness For Online Learning During Covid-19 Pandemic

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Abstract: *Every aspect of life has changed as a result of the ongoing COVID-19 pandemic. Schools and universities have been forced to conduct courses in online learning environments due to the COVID 19 epidemic. Online learning is a type of education in which students learn in a completely virtual setting. Due to the global breakout of the Covid-19 pandemic, distant learning is playing a key role in the education sector. The major goal of distance learning techniques is to improve the quality of learning and teaching in the educational system. The aim of this research is to examine the effect of online learning technology on the learning effectiveness. This survey involved both school and university students in Sri Lanka. The quantitative study was conducted by using Google Form as the online questionnaires for collecting data. The number of responses after the survey was 83. The survey helped to identify the technology involvement and effectiveness for online learning during Covid-19 pandemic in Sri Lanka. The results found that there is a powerful relationship and influence between online learning technology and learning effectiveness. Technology can be used to enhance learning in a variety of ways, including electronic grade books, digital portfolios, learning games, and real-time feedback on teacher and student performance. Furthermore, in rural areas, a lack of basic informational technical skills has a significant impact on online education. According to the research articles and survey clearly identified online learning effective for this pandemic situation and Covid-19 has impacted on education. Furthermore, this paper supports to identify online learning advantages for both school and university students and some of the most common issues students are having with online learning right now.*

Keywords: *Covid-19 pandemic, Effectiveness, Impact, Online learning, Technology*

1. Introduction

Learning is the process of becoming skilled in the creation, acquisition, and transmission of knowledge, as well as the modification of behavior.Covid-19 has been labeled a pandemic by the World Health Organization as a current threat to humanity. Therefore various activities around the world have been paralyzed. And also the Covid-19 has resulted in schools, universities shut all across the world.

Numerous schools, universities, and colleges have discontinued face-to-face education. This will have a harmful impact on educational activities because social distance is so important at this period. Due to its contagious nature, Educational institutions are attempting to develop new ways to deal with this tough situation. As retaining social distance was recommended during the Covid-19 pandemic, online learning remained the best option. Therefore all are refer to online learning for their studies. Because of this Covid-19 pandemic, technology has gained momentum all activities. "Online learning" refers to education that takes place over the internet. As a basis for online learning are need laptop or smart phone, internet connection and technical knowledge. Many students and teachers are unable to interact with one another without physically meeting, therefore all are connected remotely through computers and the internet in the case of a pandemic.

Distance learning is easy with the support of a variety of educational platforms and learning management systems. Online communication platforms such as Zoom, Microsoft Teams, Google workspace, Dropbox, Microsoft 365, GoTo etc. are act as an intermediary for students and teachers. Schools and universities can use digital resources to help teaching and learning in a variety of ways. Students' participation can be increased, teachers' lesson plans can be improved, and personalized learning may be facilitated through the use of digital learning technologies in the classroom. Technology can be used to enhance learning in a variety of ways, including electronic grade books, digital portfolios, learning games, and real-time feedback on teacher and student performance. Self -learning, better time management, improved virtual communication and collaboration, self-motivation, critical thinking skills are some of benefits using online learning. However, the effectiveness of online learning differs by age group. Children especially younger ones, require a regulated environment and parent's constant attention for studies because they are more easily distracted. And also students who do not have reliable access to technology resources, require consistent internet access to connect to their online education.

In this research use the survey-based questionnaire method to elicit students' responses regarding online learning effectiveness. In this study, investigate the following research questions: Is there any impacts on education due to Covid-19 pandemic? Is any educational benefits of technology in the Covid-19 pandemic? Is the use of technology in education is effective due to the Covid-19 pandemic? The objectives of this research is to determine the impact of the Covid-19 pandemic on education. Secondly, to determine the educational benefits of technology in the context of the Covid-19 pandemic. Furthermore, to determine whether the use of technology in education is effective due to the Covid-19 pandemic.

The aim of this research is to examine the effect of online learning technology on the learning effectiveness. This article discussed the impact of the Covid-19 pandemic on education, educational benefits of technology in the context of the Covid-19 pandemic and also effectiveness of online learning during Covid-19 pandemic situation.

After examining all of the survey respondents' responses, the total number of respondents who have stated online learning is effective and ineffective was compared, and the majority of respondents have stated it as effective.

2. Literature Review

Online education is deeply rooted in adequate planning and designs of instructions with several available theories and models. The crisis-response migration methods of universities, faculty, and students, as well as challenges and opportunities, were discussed, and it was clear that online learning differs from emergency distant teaching. Online learning will be more sustainable, while instructional activities will become more complex, if the challenges faced during this pandemic are well explored and transformed into opportunities. This study researched challenges of online learning. Pandemic-related anxiety will have negative effects on student academic performance, academic performance of students might be affect by racial, economic and resource differences and the larger parts of instructors were not effectively ready to deliver high – quality instruction remotely. Online learning on its own has advantages, such as flexibility, interactivity, self-pacing and opportunities. [1]

Students' low engagement and participation, less interactive class, and network bandwidth problems were some of the challenges identified in the study. Accordingly, the study suggested for effective online learning, there are various factors to consider. The highly recommended features were instructor orientation and adequate training, as well as the use of effective monitoring methods. The study also found some of the online class's benefits. The most frequently reported goals were to improve technology skill and knowledge, encourage self- regulation, and save time and

money. Simultaneously, the study identified a number of difficulties faced by international students. Low student engagement and motivation, a less involved class, network bandwidth issues, difficulties expressing gestures and emotions, poor use of instructional time, and difficulty using digital tools were all indicated. [2] Students' low engagement and participation, less interactive class, and network bandwidth problems were some of the challenges identified in the study. Accordingly, the study suggested for effective online learning, there are various factors to consider. The highly recommended features were instructor orientation and adequate training, as well as the use of effective monitoring methods. The study also found some of the online class's benefits. The most frequently reported goals were to improve technology skill and knowledge, encourage self- regulation, and save time and money. Simultaneously, the study identified a number of difficulties faced by international students. Low student engagement and motivation, a less involved class, network bandwidth issues, difficulties expressing gestures and emotions, poor use of instructional time, and difficulty using digital tools were all indicated. [2]

The implementation of distant learning requires the use of electronic devices that can support and access information, such as smart phones, PCs, Android tablets, and laptops. Online learning was inefficient during the Covid-19 pandemic, and that there are still many challenges. Special supervision is required for both teachers and students in order for learning to be effective and easy. [3]

Participants had both positive and negative experiences when receiving online education. Participants' positive experiences were assisted by the flexibility of class participation time and self-paced study, as well as the cost effectiveness of online classes, electronic research availability, well-designed course layout, ease of Internet connection, easy navigation of the online class interface, and familiarity with the instructor. Delay in receiving feedback from the instructor, lack of technical help from the instructor, lack of self-regulation and self-motivation, isolation, boring instructional methods, and poorly designed course content were all factors that contributed to students' negative experiences. [4]

Coronavirus is a highly contagious disease that is rapidly spreading among humans. According to the findings of this study, the quality of the instructor is the most important element that influences student happiness during online lessons. Students' expectations are the second most important element affecting student satisfaction during online sessions, according to the current study. Feedback is the third component that influences student satisfaction. Design is the final component that influences student pleasure. [5]

Effective online education, according to the authors, requires well-designed course content, motivated interaction between the teacher and learners, well-prepared and fully supported instructors, the establishment of an online learning community, and quick technological advancement. As a result, the study recommends providing a platform for educators and policymakers to explore how to build and deliver effective online programs. [6]

This pandemic crisis posed a challenge to the global education system, forcing educators to switch to an online style of teaching almost immediately. This study investigated into the growth of EdTech start-ups during pandemics and natural disasters, as well as providing recommendations for academic institutions on how to deal with the challenges of online learning. Live online classes, web conferencing, webinars, video chats, and live meetings are all possible with Zoom. Due to curfews, most schools, colleges, universities, and businesses are closed, and most people work from home, this software helps in keeping people linked via video conferencing. [7]

Innovative networks of technology, such as Edmodo, social media, forum, Coursera, or special higher education platforms, apply computer-managed e-learning to immersive online learning. According to the research, online learning is an engaging and productive source of learning for students that helps with simple administration and accessibility of distant learning along with less use of resources and time. Furthermore, this study relates to areas of access where not many students have sufficient technology services that are linked to promoting conditions, especially Internet access. [8]

Learners' ability to gain from online education during Covid-19 is determined by their past online or mobile learning experience. The shift to online learning does not happen overnight. It all starts with computer-based learning and technological developments. According to the findings, differences in factor scores are positively connected in students' perceptions of online preference, efficiency, success, and involvement during online learning, but negatively correlated in assignments, tasks, and tests. The study's most important finding is that Pearson's r score for assignments, examinations, and other online learning tasks was low. [9]

During the lockdown, students were mostly bored, uncomfortable, and frustrated, and expressed concerns about their future professional careers and study challenges. As onsite sessions were transferred online, semesters were postponed, and tests were rescheduled, the pandemic period was undoubtedly unprecedented and extremely stressful for students. [10]

To control the Covid-19 pandemic, physical distancing, and quarantine measures were mandated. In an effort to meet this mandate while trying to maintain the status quo, various types of human behavior (e.g., shopping,learning, working, meeting, and entertaining) shifted from offline to online, resulting in an accelerated diffusion of emerging digital technologies among ordinary people, while the digital divide further increases between citizens with versus without access to the technologies. In terms of daily use and digital technology, the most prominent activities were tracing, analyzing data, predicting/forecasting, and diagnosing the virus, and digital solutions significantly protected and supported public health. It provided a better understanding of education and highlighted the transition to online learning. [11]

Platforms that can successfully support the teaching and learning process. Students and instructors do not need to be in the same room; the teaching and learning process can take place from home or in other locations where students and teachers feel comfortable delivering and receiving material related to the day's major topic of class. The teaching and learning process can go smoothly with a good internet network. The online system is still in its early stages of development, but it has made significant progress. This is feasible because information technology has advanced to the point that all advances are now possible. As a result, the concept of learning through online systems can be effectively implemented. [12]

3. Methodology

The objective of this paper is to find how much effectiveness online learning during Covid-19 period. A survey was created to get enough responses covering the area of school students and university students. This survey involved within school students and university students in Sri Lanka. The contribution of this study is to examine the effect of online learning technology on the learning effectiveness.

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From the first stage of the survey, engaged with the research question based on the technology involvement and effectiveness for online learning during Covid-19 pandemic. In the second step, establish the content identification of the research papers that were read during the studies. In the third step, decided to do a survey based

on the research questions. In the fourth step, collected the data from the survey that had been analyzed. From the last step determined the last outcome based on the survey.

At first, testing was to decide the facilities of having adequate materials for online joining school and university students. And have looked up about the students' performance of online learning, impacts of transition from traditional learning methods to online learning methods, challenges faced in online learning, benefits and symptoms after changing the technology based method. The questionnaire comprised of using technology involvement and effectiveness for online learning during Covid-19 pandemic. Information was gathered and organized using a Google form. The number of responses after the survey was 83.

4. Results and Discussion

The questionnaire is conducted to identify technology involvement and effectiveness for online learning during
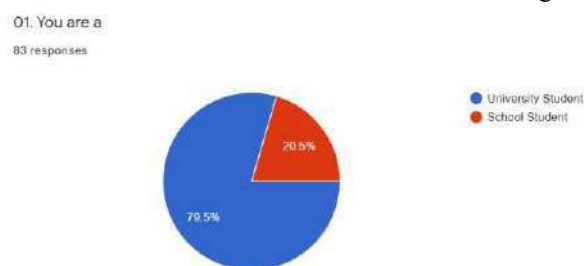

Figure 1: School or University student

Covid-19 pandemic in Sri Lanka, according to the school students and university student's perspective. The questionnaire contains 15 questions for the audience for the better understanding. 83 valid responses are recorded that qualify for data analysis.

According to the results the majority are university students and the percentage is 79.5% while the school students are 20.5%. By considering the survey results, survey supports to solve the research questions.

Because of the Covid-19 pandemic, students need to electronic devices to learn from online platforms. Some students faced many difficulties unable to get electronic devices for their studies. Figure 2 shows the devices of using school and university students for online learning.

Figure 2: Online learning devices

According to the survey results, 8.4% are using computer, 71.1% are using laptop, 12% are using parent's smart phone, 51.8% are using personal smart phones and 4.8% using tablets for log in to online studies.

Some of school and university students engage in any other activities while listening to teachers/lecturers during the teaching. Following figure 6 shows the students who engage any other activities while listening the lectures.
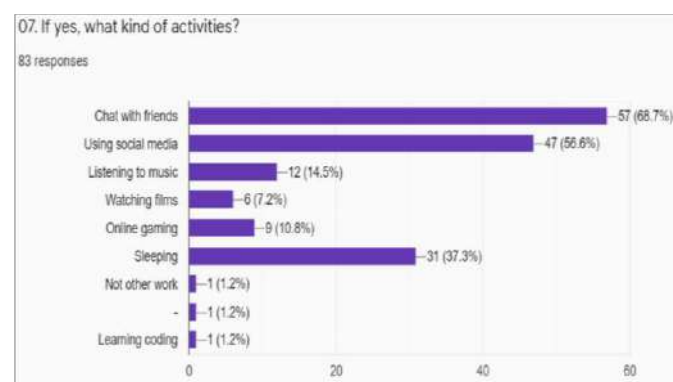

Figure 3: Other activities while listening the lectures

In home based online learning creates a less teacher-student interaction than physical attending. Therefore most of the students focusing other activities when listening lectures.

According to the results received 68.7% chat with friends during the lecture time. And also 56.6% using social media. Furthermore, some of school and university students engage listening to music, watching films, sleeping and learning coding in the lecture time.

Some of the most common issues students are having with online learning right now.

09. What are the challenges you face during online learning?
83 responses

Figure 4: Challenges of online learning

Figure 4 shows the challenges are faced on during this pandemic period. When discussing the survey results 91.6% students are faced on connection issues,57.8% are electricity problems,39.8% are technical problems,48.2% are high data cost,15.7% are language or technical knowledge problems and 1.2% are not facing any other challenges. Many students are unable engage with the high bandwidth or the strong internet connection that online courses require may be high data cost or rural area. Furthermore, many students find fixing basic computer problems troublesome, as they have no knowledge in technical area. However, technological knowledge is a must for following online courses. It allows students to keep control of their assignments and course materials without having to struggle.

08. Is there any impacts on education due to covid-19 pandemic?
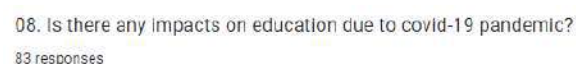83 responses

Figure 5: Covid-19 impact

According to the results received 90.4% of the respondents believe that Covid-19 pandemic has impacted on education and on both university and school students. The Covid-19 pandemic has both positive and negative impacts on education. According to the positive responses received from the survey, online learning allows students to spend more time with their families, the use of technology can help students understand and retain concepts better, and students have more opportunities to learn new things. However, the majority of students stated that the Covid-19 pandemic has negative impacts on education as well. For example, some students do not have electronic devices to learn from online platforms, and the majority of students have poor signal strength, and some students cannot afford Wi-Fi facilities. Due to technical and health issues, students have found it more difficult to concentrate on online lectures than in lecture halls, they are unable to obtain a true school

experience, there is less teacher-student interaction, and children are addicted to online gaming, among other negative effects on education during the pandemic period. Due to online learning some students have missed practical sessions as well. Furthermore, some students believe that class attendance is required for education. Many students believe that once the pandemic crisis begins, they will be physically unable to attend lectures, school, and classes, which will have an influence on education.

According to the survey, there are a number of advantages to switching from traditional to online learning methods. Some of them are time saving, easy to learn in comfortable home environment and no need to travel therefore cost saving, students can learning how to use the technology and new technological skills, students can gain self-discipline and responsibility. And also Students can also look back to lecture recordings if they forget something or miss a lecture. It is beneficial in resolving challenges encountered during self-study. According to the results the majority of respondents answered that they can stay at home and learn in a safe setting during this time.

Virtual classrooms may create serious mental health issues for many students. As a result of the pandemic and online learning, others may suffer new changes in mental health and mood. Following figure 6 shows the symptoms that faced by online learning. According to the results some of students affected symptoms such as headache, eye strain, neck ache, apathy and back pains moving to online learning.
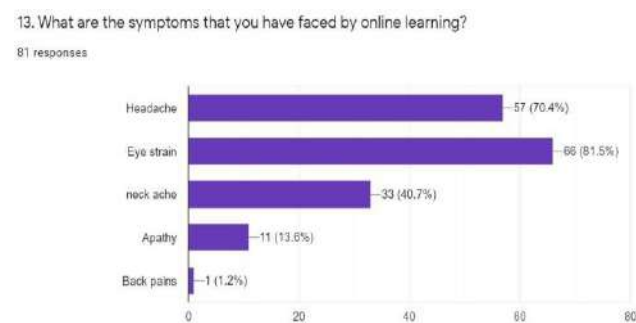

13. What are the symptoms that you have faced by online learning?
81 responses

Figure 6: Symptoms after engaging online learning

15. Online learning effectiveness
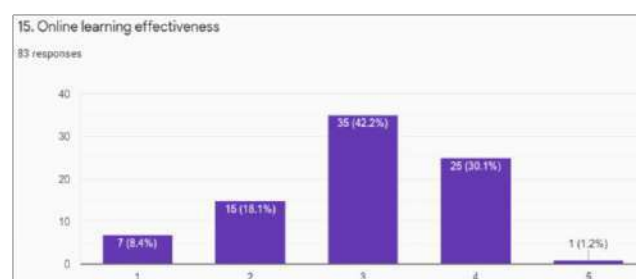83 responses

Figure 7: Online learning effectiveness

Figure 7 shows the summery of the effectiveness of online learning. Out of all the respondents 42.2% strongly agrees

that online learning is effective during this Covid-19 pandemic situation and resulted in many benefits for the school students and university undergraduates.

5. Conclusion

After thoroughly evaluating the data contained in numerous research articles and survey, it was clearly identified the technology involvement and effectiveness for online learning during Covid-19 pandemic in Sri Lanka. The evolution of technology has become a huge impact to our future.

In the current Covid-19 pandemic situation in the world, the field of information technology has expanded due to closure of educational institutions, which has caused barriers to student's traditional methods of learning. Online learning remains the best alternative during the Covid-19 pandemic as keeping social distance was advocated. Through the survey created, it received sufficient responses covering by the area of school and university students in Sri Lanka. The questionnaire was comprised of technology involvement and effectiveness for online learning during Covid-19 pandemic. Quantitative data were deciphered using this survey. As per the given responses, 90.4% believe that Covid-19 pandemic has impacted on education and on both university and school students. It has both positive and negative impacts. And also students need a fundamental knowledge of computer hardware and software for participate in online classes without interruptions. However, due to the pandemic period online learning gets the lot of benefits both school and university students. After examining all of the survey respondents' responses, the total number of respondents who have stated online learning is effective and ineffective was compared, and the majority of respondents have stated it as effective. As a result, despite its shortcomings, online learning has proven to be effective during the Covid-19 pandemic.

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Machine Learning Based Mobile Robot Localization in Indoor Environments

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Abstract: The mobile robot Indoor Positioning Systems (IPS) are widely used in the automation industry to find the location of moving robots in indoor environments. Existing IPS are expensive, and designs are complex. Moreover, the requirement for further installation work seems to be a common problem in these applications. This paper proposes a simplified localization technique based on the Received Signal Strength (RSS) by employing Machine Learning (ML) algorithms. The collected Received Signal Strength Indicator (RSSI) data from three different anchor nodes in the testbed has been trained using supervised learning algorithms to estimate the mobile robot's geographical location. During the experiment, several algorithms were investigated and Decision Tree Regression (DTR) algorithm outperformed with 28.84 RMSE and 0.9 R^2

Keywords: Indoor Positioning Systems (IPS), Machine Learning, IoT, RSSI, Mobile Robots

1. Introduction

The Internet of Things (IoT) can be identified as the extension of internet-connected devices such as sensors and actuators for a specific purpose. In modern transportation, medicine, elderly care, agriculture, smart building, smart cities, energy management, and other systems, the deployment of IoT devices and their applications are significant. Many mobile robot applications require localization (Moreno, 2002). Some examples are humanoid robots, unmanned rovers, entertainment robots, elderly assisted robots, pick-and-place robots, and Automated Guided Vehicles (AGVs). Some of these applications require very precise localization techniques which require sophisticated navigation or localization techniques such as vision cameras, magnet stripes, or laser sensors (Jiménez, 2019). These high-precision localization techniques are expensive and challenging to implement during the operation unless implemented during the initial stages. However, some applications require more minor precision localization requirements for mobile robots. For those

applications, it is essential to implement a technique to quickly set up with less hardware where IoT can dominate. Much research works on emerging applications has been conducted in the field of IoT and, indoor localization falls under the Location-Based-Services (LBS) IoT applications. This (Indoor Positioning System) IPS, a set of wireless sensors, are strategically installed in the indoor environment and these nodes communicate with the mobile sensor node (mobile robot). Depending on the application scenario, the data transmission can be done as a Local Area Network (LAN) or an IoT-based cloud architecture (Hasan, 2015). Furthermore, location-based IoT applications are widely used in industrial and commercial applications due to their low cost and small size (Maduranga, 2021). In this acquisition Wireless Sensor Network (WSN) associated with IoT, used for storing, monitoring, and processing data on a remote storage server. WSN-based indoor localization can utilize a variety of measurement methodologies, including time-based, angle-based, and RSS-based observations. In a WSN, the RSS represents the energy level of the received signal from the deployed sensor nodes. The RSS signal energy was quantized to generate the RSSI, which was then processed for indoor position estimation. RSS-based localization estimates the position of an object or a person in an indoor setting. Several algorithms are being developed to estimate position, such as deterministic, probabilistic, and machine learning. With a deterministic method, triangulation and trilateration techniques are commonly used. With fingerprinting techniques for diverse environments, machine learning-based supervised learning, and probabilistic approaches are applied. The RSSI measurement data are used in the presented research for position estimation using deterministic and machine learning techniques. The RSSI data for the study was collected from the dataset presented (Weerasinghe, 2019). The obtained data was then run through a localization algorithm, and the RSSI-based position estimate algorithms were compared.

The rest of the paper has organized as follows. Section II presents the recent works on ML-based localization.

Section II explains the ML model developments and implementation. The section IV shows the comparative performance analysis of each algorithm, while section V concludes the findings.

2. Related Work

According to the literature, time-based, angle-based, RSS-based, or a combination of these three techniques are commonly used for signal gathering in indoor localization (Zhang, 2010). The time of arrival (TOA) [8] and the time difference of arrival (TDOA) (Maduranga, 2014) are time-based measures related to transmission time that can be used for position estimation. The angle of arrival (AOA) (Farid, 2013) is used as an angle-based position estimation that requires a highly advanced directional antenna as the beacon node for angle measurements. Additionally, indoor localization can be accomplished via triangulation and trilateration (Zhu, 2013) techniques. According to the literature, the RSS-based trilateration localization approach is the most often used algorithm due to its ease of use and broad applicability range. Furthermore, researchers used neural network strategies for WSN localization at the dawn of machine learning (Alsheikh, 2014), (Di, 2007) because they are well suited for prediction from sample data to a specified output.

Any wireless-based range and positioning system where the distance is estimated based on the strength of the received signal from the sending node relies on the correlation between the RSSI and the distance (Zhang, 2010), (Ahn, 2010). (Payal, 2014) A cost-effective localization framework proposes a WSN-based localization approach based on a Feed-Forward Neural Network (FFNN). (Sugano, 2006) employed ZigBee-enabled transceivers, as well as embedded microcontrollers and microprocessors, in their RSSI-based localization tests. Rajeev Piyareet et al.'s work on a WSN-based data acquisition system using a ZigBee device requires a separate microcontroller unit to gather data (Piyare, 2013).

The two approaches of location estimation, trilateration and Machine Learning (ML), are compared in terms of performance. Based on the findings, we chose the most appropriate position estimation technique for the models from the abovementioned options. It should be emphasized that because RSSI readings are relatively unstable in terms of time and position, proposing a highly stable and accurate localization technique is challenge. Therefore, the RSSI technique does not give realistic values by using deterministic models, like time, angle, or geometry-based techniques. The paper addresses the issue of giving a validated solution for highly approximated localization using ML for RSSI.

Model Development And Training

For the implementation of study, a dataset introduced by (Weerasinghe, 2019) was utilized after filtering the outliers from the original dataset following the method given in the same study. Then the traditional trilateration technique was implemented using the given dataset. Finally, machine learning models also were trained and tested using the same dataset.

A. Dataset

WSN area is a 293.8 cm x 274.6 cm obstacle-free indoor space surrounded by walls. The hardware setup of the WSN used for collecting data (Weerasinghe, 2019) consists of three fixed beacon nodes and one mobile node. All beacon nodes and the mobile node in this WSN were Wi-Fi sensors that were based on IEEE 802.11 standard. The mobile node scans and records the Received Signal Strength as RSSI of three beacon nodes. The beacon nodes are fixed in known arbitrary corners.

In contrast, the mobile node has moved in x and y directions without changing the z directions displacement to limit the study to a 2D localization problem. This summarizes that the input data used for the developed models in this study are RSSI readings of three beacon nodes. The RSSI data were collected from 34 known sample positions concerning three beacon nodes. The output data are the mobile node's corresponding x and y coordinates (robot). The dataset was composed of 1200 data points and 70% of the dataset was used for training and the rest was used for testing.

B. Prediction Models Development

This study compares different machine learning models that can be used for 2D localization. We have accommodated the trilateration proposed in (Weerasinghe 2019) to present a complete study to compare with developed machine learning models. The models used in this study are as follows.

1) *Trilateration*: The linear relationship between the RSSI vs. distance (between a beacon node and the mobile node) on the log scale can be represented by,

$$RSSI = -(10 \qquad _{10} \quad + A) \qquad (1)$$

where ;
d - distance from the blind node to the reference node
n - Signal propagation constant
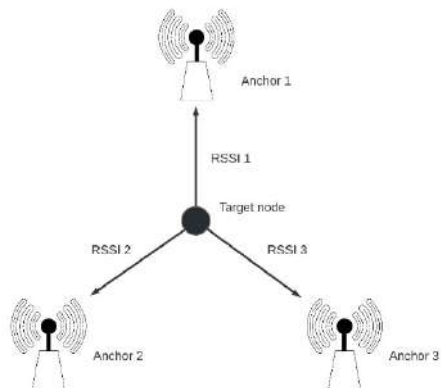
A - Received Signal strength at a 1m distance

Fig.1: RSSI-based localization

The study (Weerasinghe, 2019) has calculated and presented the propagation constant (1/10) and the constant A for the dataset used in this study. Using these constants, we were able to calculate the distance from each beacon node to the mobile node and after the position of the mobile node (i.e., x,y coordinates of the mobile node) was estimated using the Euclidian distance approach as presented in (Weerasinghe, 2019).

2) Linear Regression: When it comes to machine learning, it is always advisable to test the data fitting with a fundamental technique like Linear Regression (LR). Where x is the independent variable and y is the dependent variable as expressed in Eq.2.

$$ = \theta_0 + \theta_1 \quad + \varepsilon \ (2)$$

3) Polynomial Regression: As the second step, we have developed a 4th order Polynomial Regression (PR) model. The 4th order polynomial model in one variable is given by Eq.3.

$$ = \theta_0 + \theta_1 \quad + \theta_2 \quad ^2 + \theta_3 \quad ^3 + \varepsilon \ (3)$$

4) Lasso Regression: This is a modification of linear regression, where the model is penalized for the sum of absolute values of the weights as indicated in the objective function, Eq.4. The degree of shrinkage is controlled by λ. The predictive model is constructed using simply the residual sum of squares, which denotes that all features are taken into account. As the residual sum of squares gets closer to infinity, it eliminates more and more features.

$$ = \sum_{=1} \quad (\quad - \sum \quad \beta) + \lambda \sum_{i=1}^{p} \ |\beta| \ (4)$$

5) Random Forest Regression: Related works shows the potential of using RFR in localization problem. A supervised learning technique called Random Forest Regression leverages the ensemble learning approach for regression. The ensemble learning method combines predictions from various machine learning algorithms to provide more accurate predictions than those from a single model.

6) Decision Tree Regression (DTR): A decision tree creates tree-like models for classification or regression. It incrementally develops an associated decision tree while segmenting a dataset into smaller and smaller sections. The outcome is a tree containing leaf nodes and decision nodes.

7) Support Vector Regression (SVR): The Support Vector Regression (SVR) is heavily used in localization works (Jondhale, 2022). An approach for supervised learning called support vector regression is used to forecast discrete values. The SVMs and Support Vector Regression both operate on the same theory. Finding the optimum fit line is the fundamental tenet of SVR. The hyperplane with the most points is the best-fitting line in SVR.

8) Feed Forward Neural Network (FFNN): To provide a complete study, it was decided to try a Feed-Forward Neural Network (FFNN) as well. The neural network used in this study consisted of one hidden layer with ten neurons. The model was implemented and trained using the MATLAB R2020a (MathWorks, 2022) neural network toolbox. The model was trained up to 35 epochs using the Levenberg-Marquardt training algorithm (Yu, 2018).

The above-mentioned algorithms were trained using Python with the aid of ML libraries Scikit-Learn (Kramer, 2016). During the training the data set split into 30% for testing and 70% for training. Hyperparameters of algorithms were tuned to obtained more accurate results. Where, Maximum depth of the DTR model was set to 25.

3. Results and Discusison

Considering all 8 methods, we have compared the performance of all the models in terms of the Root Mean Square Error (RMSE), Pearson correlation coefficient (R) and training time. The comparison of the results is given in the Table 1. Since the trilateration approach is a mathematical approach rather than a machine learning training method it was excluded from the training time comparison. A few samples estimated form DTR algorithms are shown in the Fig.2. Finally, the average error made by each algorithm are shown in the Fig.3.
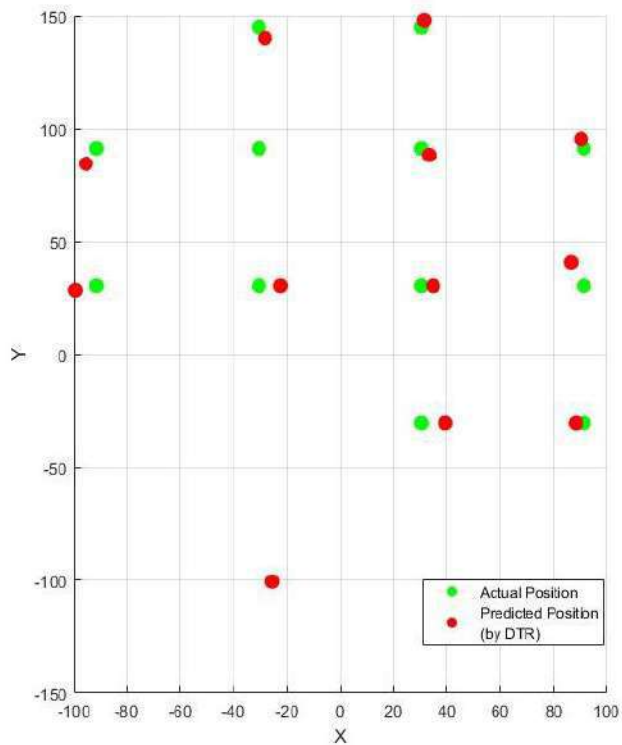
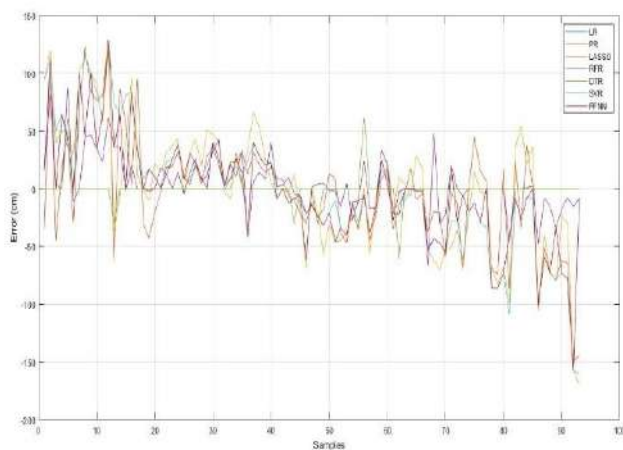Fig.2: Actual positions and estimated positions using DTR

Fig.3: Estimation error in each algorithm

The RMSE given in the following equation is a well-used indicator to identify the accuracy of a model. This denotes the accuracy of the predictions given by the model.

$$RMSE = \sqrt{\frac{\sum(\quad - \quad)}{ \quad }} \quad (5)$$

The Pearson correlation coefficient (R) given in the following equation expresses the correlation between predictions and the actual coordinates as per Eq.5.

$$= \frac{\sum(\quad_i - ^-)(\quad_i - ^-)}{\sqrt{\sum(\quad_i - ^-)^2 \sum(\quad_i - ^-)^2}} \quad (6)$$

where

Then the training time is an important indicator that identifies how fast a model can be trained and built.

We have developed independent models to predict both x coordinate and y coordinate of the mobile node using RSSI of beacon nodes and evaluate the developed models using RMSE, Pearson correlation coefficient, and training time. The RMSE, Pearson correlation coefficient and training time for the training dataset is given in Table 1.

Observing the results, it is clear that trilateration gives the least accuracy, which justifies the importance of looking at other indoor localization methods for higher accuracy. The DTR has outperformed all other models by giving the least RMSE and highest R. However, the RFR also has produced results closer to the DTR model. It is also interesting to note that both RFR and DTR models have taken the same training time. When considering the training time, the LASSO has been trained within 20 seconds which is the shortest training time.

4. Conclusion

Table 1. Performance Comparison of localization models

Model		Performance Indicators		
		RMSE	R	Training Time (s)
Trilateration	x	131.63	0.101	N/A
	y	110.44	0.139	N/A
LR	x	77.54	0.270	30.0
	y	71.75	0.419	30.0
PR	x	68.14	0.436	430.2
	y	57.21	0.631	430.2
LASSO	x	77.54	0.270	20.4
	y	71.75	0.419	20.4
RFR	x	34.65	0.854	30.4
	y	32.79	0.879	30.4
DTR	x	28.34	0.903	30.4
	y	28.84	0.906	30.4
SVR	x	73.43	0.345	40.4
	y	67.56	0.486	40.4
FFNN	x	55.08	0.803	100.3
	y	51.08	0.801	100.3

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In this work, we have done a comparative study on using the supervised algorithms for mobile robot localization. The supervised learning algorithms consistently outperformed classical algorithms such as trilateration. Statistical analysis shows that machine learning approaches have significantly less estimation error, and the DTR has given the best accuracy with adequate training time. The DTR models give the best accuracy out of the other machine learning models trained. This concludes that it is could be important to test machine learning approaches before going for the trilateration approach in indoor localization problems.

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Security Vulnerabilities and Security Elements of Frequently Used E- learning Platforms: A Review

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Abstract: *E-learning has now come to stay with renewed interest and popularity among the student population worldwide. The sudden outbreak of Covid-19 compelled the traditional education system shifted to online education mode. Online education is provided via e-learning platforms. These platforms provide easy access to students around the globe to learn, communicate and interact with each other. However, the concerns at hand are how secure these e-learning platforms are for the users. If the use of e-learning systems causes security and privacy issues then the learners will be reluctant to be exposed to the platform. Therefore, it has become a major challenge in order to ensure that only the authorized parties have gained access to the system. The purpose of this study is to investigate all possible security vulnerabilities in the current e- learning platforms and provides appropriate solutions to overcome the security threats. This study has undertaken a comprehensive review to filter the literature with respect to the security elements, threats and vulnerabilities in e-learning platforms. When analyzing the existing research, it could be identified that Moodle, Blackboard and Sakai are the most commonly used platforms. Therefore, this study is based on security threats and vulnerabilities of the forementioned platforms. It is revealed that security vulnerabilities of the platforms, Blackboard and Sakai have not addressed as much as Moodle. Furthermore, this study reveals that confidentiality and integrity are the most important security elements that need to be considered and prioritized within the e-learning environment.*

Keywords: Security Vulnerabilities, Security Elements, E- learning platforms

1. Introduction

E-learning is defined as the concept of gaining knowledge electronically or can be termed as web-based learning, mostly done through the internet (Meghna & Maitra, 2018). It provides access to users all around the world to engage in their academic endeavours successfully. It can be called as a form of distance learning as the teachers and learners are in different locations.

Luminița and Magdalena (2012) have presented some characteristics of e-learning systems. They have said that there is no physical class, so the learning and teaching processes take place in a virtual class. The courses are conducted by an instructor. All related educational materials are available as e-material on the platform.

Due to the rapid growth of Information and Communication Technology and the outbreak of Covid-19, e-learning has been very popular among students during the past few years. The pandemic caused the temporary closure of schools, Universities and several educational institutes. This situation has dramatically changed the traditional education system and lead to online learning platforms. According to Fortune Business Insights (Anon., 2020) the global e-learning market has showcased a dramatic growth of 23.8% in 2020 when compared to the growth in 2017-2019. As the demand of e-learning is continuously growing, the Learning Management Systems (LMS) are also increasing as shown in Fig 1. Therefore, in order to cater the demand, the systems need to be enhanced. However, the major concern of these platforms has been the content and delivery of the content (M., et al., 2015).
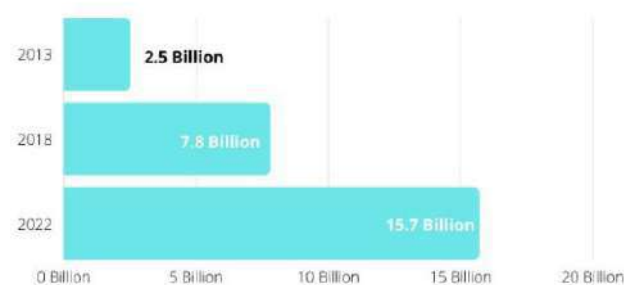

Fig. 1 LMS Growth
Source: (Anon., 2022)

Furthermore, according to (Costinela, 2011), (Khalil, et al., 2003) majority of the e-learning platforms have given the highest priority to module development and delivery, and given less priority to security and privacy of the applications. Therefore, this paper provides an overview on the security vulnerabilities and privacy concerns related to e-learning platforms.

As a student, the main factor of motivation behind this study was the Covid-19 pandemic which compelled the students to use e-learning platform instead of traditional learning. Therefore, several students had concerns on whether the platforms are secured to be used. As a result, this review was carried out to investigate security aspects of the e-learning platforms.

The aim of the study conducted here is to identify the security vulnerabilities of the existing e-learning platforms and to provide appropriate solutions to develop a better platform to overcome these threats.

This paper is organized as follows. Section 2 includes the literature review. Section 3 contains the security elements of e-learning platforms. Section 4 investigates on the e-learning platforms such as MOODLE, Blackboard and Sakai because of their adaptability, usability, popularity, and interoperability (Dube & Scott, 2014). Security vulnerabilities and techniques to overcome the vulnerabilities are discussed in section 5. Finally, section 6 concludes this study.

2. Literature Review

Luminata and Magdalena (2012) have discussed cross site scripting, SQL injection and Cross-Site Request Forgery vulnerabilities and the actions needed to be taken to prevent vulnerabilities in e-learning systems. Furthermore, they have analysed the security threats in the platform Moodle. They have concluded that to develop a secure e-learning platform security elements such as authentication, encryption, access control should be incorporated to the system.

Bokhari, Kuraishy and Ahmad (M., et al., 2015) have examined the necessity for e-learning systems, the basic security criteria of an e-learning system, and some of the possible e-learning system attacks in their study. The primary concerns on e-learning security are authentication and authorization, trust and security. However, the authors have identified that mostly security concerns are neglected when designing e-learning platforms.

The authors (Dragan, et al., 2019) have stated some standards related to information security along with their detailed specifications. They have specified that many e-learning systems have failed to be compatible with the standards initially because the standards were not developed at that period. Hence, it is difficult to provide support for standards because it would necessitate entire reengineering in some portions.

El-Khatib, Korba, Xu, and Yee (Khalil, et al., 2003) have examined privacy and security issues related to e-learning. It contains privacy principles and the way each principle needs to be implemented. Furthermore, security features of current e-learning standards have been analyzed.

Luminata, Magdalena and Baron (Costinela, et al., 2014) have described security threats to e-learning platforms from the user's and platform perspectives. They have provided details on common vulnerabilities such as cross site scripting, cross-site request forgery and SOL injection. The solutions to overcome those threats were discussed. They strongly believe that privacy and security need to be concerned when developing an e-learning system.

Kumar and Dutta (Sheo & Kamlesh, 2011) have investigated on security in the platform Moodle. They have categorized threats into four sectors as authentication, availability, confidentiality and integrity attacks. They have also provided with the reasons why Moodle should be

chosen and some limitations of Moodle. Two major attacks to Moodle, design attack and session hijacking were discussed. Finally, they have proposed solutions to Moodle security attacks. Login with CAPTCHA and Secure Sockets Layer (SSL) to avoid design attack and session hijacking respectively.

Elmaghrabi and Eljack (Yee, et al., 2003) have enhanced the security of Moodle system when online exams are held on Moodle. They have addressed two improvements; one is resolving the issue of loosing answers during an exam due to a disconnection in the network. The other is to ensure confidentiality by restricting the access of quiz using two or more devices simultaneously. They have implemented it successfully and tested using the Moodle site.

The authors (Najwa & Ip-Shing, 2010) have discussed on the security elements that are required to be implemented in e-learning environments. The development and the growth of e-learning have been discussed. Information threats such as deliberate software attacks, technical software failures and errors, compromises to intellectual property have been identified. Furthermore, Information Security Elements in e-learning have been discussed.

Fatek and Anurag (2018) have identified the threats and risks to the content of e-learning systems. They have suggested tools and techniques to mitigate the risks. They have given priority to content authentication using digital watermarking.

Meghana and Maitra (2018) have proposed a security model which can be adopted to e-learning platforms. The authors have identified security threats by reviewing existing research. They have used two well known scanners, namely Netsparker and Acunetix to examine the weaknesses in e-learning software.

I. Security Elements

According to Luminita and Magdalena (2012) in order to make e-learning platforms secured, elements such as authentication, availability, confidentiality, access control and data integrity, and content protection need to be taken into account.

Authentication is used to identify the user and to decide on user's access privileges. The authors (Luminița & Magdalena, 2012) have mentioned that it prevents the attackers to do unauthorized operations such as obtaining sensitive data. They have identified the following practices to maintain authentication. Users need to set strong passwords including uppercase and lower-case letters, numbers, symbols and some special characters. Another practice is to re-authenticate after some time limits. Most importantly, access control should be given based on roles. That will restrict the system access from unauthorized users. The role based model allows to perform certain operations which are assigned to specific roles only.

Availability is mostly neglected when considering security. However, the efficiency of users will reduce if network applications are not available 24/7 or if theory are too slow due to denial-of-service attacks. The required e-

learning materials should be accessed at anytime (M., et al., 2015) and any place. Denial-of-service attacks can be prevented by monitoring the network connection and application continuously.

Confidentiality is protecting the data of the system from unauthorised access. The author (Costinela, 2011) believes that confidentiality of an e-learning platform needs to be ensured through the access control to information. As these platforms are used by several users such as students, teachers, administrators and they access different information, hence it is a must to have high level of confidentiality. It can be performed through the login itself, by providing the correct username and password the user should only be able to access the relevant pages.

The major factor in integrity is access control (Hassan, et al., 2015). Integrity ensures only the authorized parties to access and modify data contents. Confidentiality of data has a close relationship to the integrity of the system (Costinela, 2011). Digital watermarking is used as a technique to secure the integrity of the content (Fatek & Anurag, 2018). It is mainly used as protection against manipulation and copyright.

Non repudiation (Costinela, 2011) means that the clients cannot conceivably deny to have performed activities. For example, consider a case where a teacher deletes some student's exam results. Then it should be able to trace back and identify who deleted them with the use of some log files. In addition, these log files must be reliable and tamper-proof. Auditing is the technique used to fulfill this prerequisite.

II. Security Vulnerabilities

In this section the most common security vulnerabilities in e-learning platforms and measures to overcome the threats will be discussed.

A. Cross Site Scripting (XSS)

Cross Site Scripting is the most common application layer web assault *(Costinela, 2011)*. The goal of XSS is to change client-side scripts rather than server side, in a web application so that they run in the malicious user's preferred manner. Such tampering has the potential to embed a script in a page that can be run every time the page is loaded, or when an associated event is performed *(Costinela, et al., 2014)*. An attacker can gain access to a computer using this method by compromising information or launching a denial-of-service attack.

In order to prevent an XSS attack in an e-learning platform, (Luminiţa & Magdalena, 2012) and (Costinela, 2011) have suggested the following actions.

- Ascertain that the Web site's pages only return user inputs after validating them for malicious code;

- When it comes to XSS, don't put your trust in websites that employ HTTPS (Secure Sockets Layer).

HTTPS guarantees secure communications, however the application processes the data entered by the user inside. If the application contains XSS flaws, the attacker may transmit a malicious script that the application can still run, resulting in XSS invasions.

- Before displaying user input in search engines and forums, convert all non-alphanumeric characters to html character entities.

- Use testing tools extensively during the design process to eliminate XSS vulnerabilities in the e-learning application before it is put into use.

B. SQL Injection attack

An SQL injection attack involves inserting or "injecting" a SQL query into the program via the client's input data (Costinela, et al., 2014). It allows hackers to tamper with existing data and allows to cause repudiation issues, complete disclosure of all information on the system, misuse data or make it unavailable by becoming the administrators of the database server. One of the key causes of SQL injection attacks is a lack of appropriate input validation. Web applications without input sanitization filters (Costinela, 2011) are particularly vulnerable to such assaults.

SQL Injection is a reasonably a simple sort of attack that may be avoided by following a few basic development guidelines (Costinela, et al., 2014) as follows.

- Checking for problematic characters in the user's input, such as single-quotes

- Using prepared statements, which inform the database what to expect before it receives any data from the user

- Protecting sensitive information by encrypting it;

- Ensure that the error messages don't reveal anything about the database or internal application's design.

C. Cross Site Request Forgery (CSRF)

The CSRF attack deceives the victim into loading a page with a malicious request. It attempts to take on the victim's identity and privileges in order to do an unwanted action on the victim's behalf, such as changing the victim's e-mail address, home address, or password. CSRF attacks are usually directed against functions that change the state of the server, but they can also be used to get access to sensitive information (Luminiţa & Magdalena, 2012). It can be avoided from the following measures (Costinela, et al., 2014).

- Need to store state when user browsers
- Check state
- Hiding filed state of HTML form

III. E-Learning platforms

Moodle, Blackboard and Sakai *(I.Bandara, et al., 2014)* are some commonly used e-learning platforms worldwide. These platforms consist of large number of users and resources. Therefore, information should be handled carefully in order to enhance confidentiality, integrity and availability.

D. Modular Object-Oriented Dynamic Learning Environment (Moodle)

Moodle is an open source (Luminița & Magdalena, 2012) e-learning platform that is used by several universities and educational institutes all around the globe (Sheo, et al., 2011). At present Moodle is facilitating nearly 300 million users of 242 countries (Anon., n.d.). It runs on any computer that supports PHP, for Unix, Linux, and Windows operating systems (Azza & Sarah, 2019). It can support various databases including Mysql and the application is available in 12 languages (Azza & Sarah, 2019).

Martin Dogiamas is the inventor of Moodle (2002). In its structure, the system takes educational rules into account. It is based on a theory of education that is detailed in the documentation. Hundreds of developers work on Moodle around the world, and it is constantly updated. Moodle can accommodate 40,000 students at a university and is multilingual. It is built using PHP and MySQL and adheres to the Global Standard for Digital Course Design (SCORM).

According to Kumar and Dutta (Sheo & Kamlesh, 2011) Moodle contains a good architecture, implementation and high inter-operability. However, it has a few limitations such as less SCORM support and limited role and permission system. They have further identified the following security attacks in Moodle.

1. Design Attack – Moodle is vulnerable to the prediction of usernames and passwords. Brute force attack can be used to predict usernames and passwords. In a brute force attack the attacker tries out all possible combinations of passwords (Luminița & Magdalena, 2012) until the correct one is found.

2. Session hijacking – It is a form of eavesdropping attacks. An attacker is interested in the communication between the client and the server. They're looking for information within the payload, which in this case is the HTTP requests. The information that can be used to deceive the user and make his or her session more appealing.

However, Moodle provides better security against common threats. Through the settings of Moodle, only the system administrator can make relevant changes IP blocker, site policies, HTTP security, notifications and antivirus as shown in Fig 2.

Fig. 2 Security settings in Moodle
Source: (Azza & Sarah, 2019)

E. Blackboard

Blackboard is a commercial (Azza & Sarah, 2019) learning management system where a licence is required to use the system. It provides services to students as well as instructors in institutions. It may enable real-time activities such as chat rooms, which can be used to send documents from students to instructors and instructors to students (Tawalbeh, 2017). Blackboard also provides course management features for academic staff, such as grading, tracking student interaction and class progress (Targrees, et al., 2016). Furthermore, video and audio files, graphics can be attached to Backboard system (Targrees, et al., 2016). Therefore, blackboard enhances student collaboration and engagement (Rawda & Amal, 2020). It is currently being used by more than 100 million users.

When analysing the security vulnerabilities of Blackboard, Cross site scripting (XSS) is identified as the most common vulnerability. XSS enables to steal user credentials of Blackboard users (Willem, et al., 2012). Furthermore, Blackboard does not provide sufficient authorization when accessing files.

When considering on security aspects of Blackboard system, it prevents unauthorized access by allowing only the registered students and instructors to login and access the content (Targrees, et al., 2016).

Blackboard allows to assign primary and secondary roles to users. For example, a lecturer can be a teaching assistant for some courses. According to the Fig 3 there are many roles such as Facilitator, Goal performance viewer, Goals manager, Guest, Learning environment administrator etc. This role based restrictions will prevent unauthorized access.
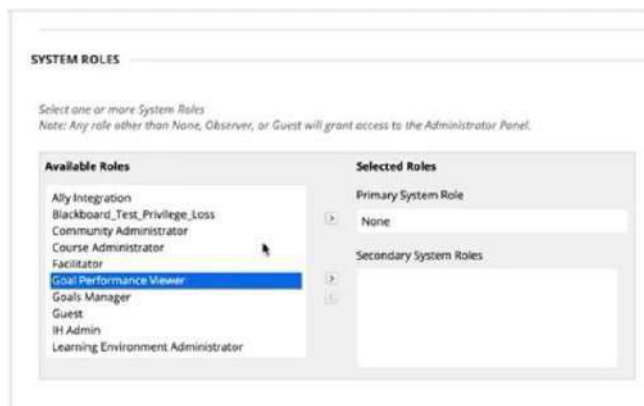

Fig. 3 System roles in Blackboard
Source: (Gonzalez & Elizabeth, 2020)

F. Sakai

Sakai is a free and open-source, academic software platform designed to assist teaching, research and collaboration. It is programmed in Java. It is a platform that is developed on a central plan model. It contains a user-friendly interface (Jyoti, et al., 2015). However, it is not very popular when compared to Moodle.

Sakai learning management system has integrated with Adobe Connect. It allows to securely create, manage and launch meetings. When meetings are launched it entitles to a class roster security feature.

It offers robust options to manage accounts and assign user roles (Cruz, 2010). That enables proper authentication.

3. Discussion

Out of the 18 papers reviewed, from majority of the papers it was evident that most e-learning platforms have prioritized content development and delivery, with very less concern given to privacy and security.

Table 1. Issues On Security Elements and Solutions

Security element	Issue	Solution	Number of Papers	% Of Papers
Authentication	Insecure communication, Session management	Set strong passwords, Re-authenticate after session expire	4	57%
Availability	Denial of service	Monitoring the network connection and application continuously	5	71%
Confidentiality	Hackers, Insecure cryptography, Trojan horses	Restrictions on access control, Role based access	7	100%
Integrity	Buffer overflow, Malicious file execution, Unauthorised programs	Allow access only to authorised parties, Digital watermarking	6	86%
Non repudiation	Users deny carried out operations	Ability to trace back and access log files, Digital signature	2	29%

According to Table I, based on the comprehensive review conducted, it is evident that all seven papers containing security elements have addressed on 'confidentiality'. Therefore, 'confidentiality' can be considered as the most important security element when developing an e-learning platform. All confidentiality related issues need to be handled with proper care.

86% of the researchers suggest that 'integrity' is crucial and that need to be considered when designing e-learning platforms. Integrity can be ensured by allowing access only to authorized parties, with the use of digital watermarking to overcome buffer overflow and malicious file executions.

Denial of service attack, which is related to the element availability, and it's solutions have been addressed in 71% of the papers reviewed.

Only a minority of 29% have discussed the issues related to non-repudiation and its' solutions. Therefore, it seems to be the least important security element. However, it needs to be given further consideration.

Therefore, it is clear that out of the five security elements, confidentiality and integrity should be given the highest priority in e-learning environments.

Table 2. Vulnerabilities of E-Learning Platforms

Security vulnerability	E-learning platforms		
	Moodle	*Blackboard*	*Sakai*
Cross-site Scripting	√	√	X
SQL Injection	X	X	X
Cross-site Request Forgery in login	√	√	√
Brute force attack	√	X	√
Session hijacking	√	X	X
HTTP Header Injection	X	X	√
Insufficient authorization	X	√	X
Total papers reviewed	9	3	2
% Of papers	64.3%	21.4%	14.3%

From the above Table II, it is evident that majority of the researchers (64.3%) have investigated the platform Moodle. They have identified that Cross-site Scripting, Cross-site Request Forgery in login, Brute force attack and session hijacking as the main threats to Moodle.

21.4% of the researches have analyzed the platform Blackboard and have identified Cross-site Scripting, Cross-site Request Forgery in login, and Insufficient authorization as vulnerabilities to the platform.

The least number of researches had been conducted on Sakai learning management system. It was revealed that vulnerabilities such as Cross-site Request Forgery in login, Brute force attack, HTTP Header Injection do exist in Sakai.

Most importantly, all three platforms have avoided the SQL injection attack.

It could be identified that when analysing security vulnerabilities in e-learning platforms majority of 64% of papers are only considering Moodle, even though there're so many platforms. Therefore, I believe further research can be done on analysing other e-learning platforms.

4. Conclusion

This paper has critically reviewed the existing research on security vulnerabilities on e-leaning platforms. Specifically, this paper has an insight on security elements in e-learning platforms, security concerns in the platforms of Moodle, Blackboard and Sakai. Furthermore, common security threats and measures to overcome the threats in e-learning platforms have been discussed. It was identified that confidentiality and integrity are the most critical security elements in the e-learning environment. It was further revealed that not considerable research had been done to investigate the security issues in Blackboard and

Sakai when compared to Moodle. A limitation of this study is that only three platforms have been considered to analyze several security vulnerabilities. However, since those three platforms are the commonly used platforms this review can be considered as successful.

5. Future Work

This review was done in order to investigate the security vulnerabilities related to e-learning platforms with a view to develop an exclusive internal system for the institute so that the user's information will not get exposed to a 3rd party organization. Depending on the availability of time it is further intended to improve this platform to identify the emotions and expressions of the users and furthermore, to observe whether the participants are actively participating to the lecture and are fully focused.

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A Review on the Application of Artificial Intelligence and Automation in Digital Forensics

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Abstract: As a branch of forensic science, Digital Forensics is concerned with identifying, acquiring, processing, analysing, and reporting on digital data. For law enforcement investigators, Digital Forensics support is crucial since electronic evidence is present in almost all criminal activities. An array of electronic evidence can be gathered from a variety of sources, including computers, smartphones, remote storage, unmanned aerial systems, and shipborne equipment. The main objective in Digital Forensic is to extract data from electronic evidence, process it into actionable intelligence and present the findings for prosecution. The success, efficiency, and efficacy of a typical forensic inquiry are significantly influenced by the knowledge and prior experience of the investigator or any security agent. The outcomes of a digital investigation will be more effective and efficient if the power of intelligence in the available computer resources is utilized. In modern computer science, Artificial Intelligence (AI) is a well-established field that can often provide a means of solving computationally complex or large problems in a realistic timeframe. The influence of AI on several fields in modern society and its achievements throughout time suggest that it can help with a variety of challenging Digital Forensics investigative issues. This review paper outlines various methods of evaluating, optimizing and standardizing applications of artificial intelligence and Automation models used in digital forensics.

Keywords: Digital Forensic, Artificial Intelligence, Automation, Machine Learning, Intelligent Forensics

1. Introduction

Most of us heavily rely on digital devices and the Internet to operate and improve our quality of life and/or businesses as a result of the development of technology. We rely on these tools and technologies to process, store, and transfer data, which causes a large volume of data to be created, gathered, and shared electronically. In recent years the occurrence of malicious cyber activity has increased as many individuals and international cooperate sector depends on digital infrastructure of the highest level and Information and Communication Technologies (ICT). Data breachers, information leakage, information security breaches, hacking, malware and ransomware attacks, phishing scams and botnets are some of the malicious activities that have caused severe loss for companies and individuals. As a result, companies have resorted to cyber-crime prevention and detection.

There has been extensive exploration of computational intelligence techniques in a variety of domains. Digital Forensic is such domain. Digital forensics is also referred to as computer and network forensics. Using science, Digital Forensics involves identifying, collecting, examining, and analysing data, while protecting its integrity and maintaining a strict chain of custody (Kent, Chevalier, Grance & Dang, 2006). Simply Digital Forensics can be defined as the process of identifying, preserving, analysing, and documenting digital evidence that is to be presented as evidence in court of law when required. Digital Forensics traces its roots back to 1970 when engineers recovered the only copy of a database that was deleted unintentionally (Garfinkel, 2010). Digital Forensics Investigators are individuals who follow evidence and solve crimes through digital means. Digital Forensics Investigators role is to recover deleted files, cracking passwords, finding the initial source of a security breach and after collecting the evidence is then analysed, stored, and translated to make it presentable before the court of law (Digital Forensics, 2022). Security experts, law enforcement agencies investigating cybercrime and Digital Forensics investigators face new challenges as a result of today's massive amounts of data, heterogeneous technologies, borderless networks and complex modern hardware/software frameworks. From both ethical and technological perspective, modern Digital Forensics face obstacles.

Artificial Intelligence (AI) is the simulation of human intelligence processes by machines, especially computer systems. Machine Learning, Deep Learning, Expert systems, natural language processing, and speech recognition are some applications of AI. Automation is the combination of modern hardware and software to carry out a task or process with zero or minimal human invention. In the context of AI, large volumes of labelled training data are ingested, analysed for correlations and patterns, and predictions are made based on the patterns found in the data. Automation and Artificial Intelligence are two modern computing fields that work together. The idea of AI is to simulate the cognitive and reasoning processes of the human brain to help streamline and/or automate laborious procedures. Massive development efforts are being made to create AI powered software, applications, operating

Figure 1. Methodology for systematic literature omatea wide

Factors such as technology used, drawbacks of the technology, user feedback, advantages, methods followed,

range of processes, operations, and activities. The main aim by integrating AI and Automation is to achieve efficiency, accuracy, and cost-reduction. Machine Learning (ML) is a section of AI. When a computer system or algorithm can process a large amount of data and ultimately can draw predictions and conclusions it is referred to as Machine Learning (Choy et al.,2018). Machin Learning analyses historical data using regression models and classification to form future predictions. Intelligent Automation (IA) is a term used to refer to technology solutions that make use of AI, Automation, and machine learning (Jarrett & Choo, 2021).

Digital forensics is a complex and evolving field where AI and Automation is making significant headway. AI, ML and Automation are considered as emerging application in Digital Forensics. It is also recorded that the US Federal and State Law Enforcement Agencies have been investigating the potential applications of technology that is powered by Artificial Intelligence to improve the effectiveness of Digital forensics (Jarrett & Choo, 2021). This will result in increasing the accuracy of Digital Forensic investigations. The field of Digital Forensics is one that is taking on greater significance in computing and frequently necessitates the thoughtful study of vast quantities of complex data. Therefore, it would appear that using AI is the best strategy to address many of the issues that Digital Forensics is currently facing. AI can be used to help identify hidden trends in the collected evidence as AI has no bounds to how much data it can process and analyse.

2. Methodology

In this section of the document the methodology and approach followed in conducting the review is discussed. For the purpose of composing this review, a systematic stategy was used, in which the topic, angle, goals, and title were selected initially. Research articles, documents and resources were explored and analysed. These were then used to develop a deeper knowledge of the ideas, concepts, and technology and then further studied and reviewed thoroughly, to find the data and information that will be most useful and acceptable for this investigation. To do this study, articles between 2000 to 2022 were found via Google Scholar and other research archives using keywords related to Digital Forensic, Automation and Artificial Intelligence. The criteria followed when selecting research articles for the study are as follows:

- English-language writings that are clear
- considering research conducted during the 2000 to 2022.
- Accessibility of the entire document or article
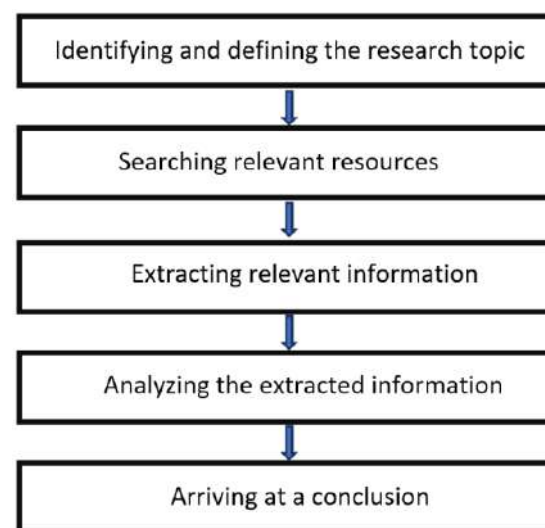
case studies and etc were thoroughly reviewed, analysed, and compared during this study.

Finally, conclusions were reached by using the data and expertise obtained through reading, analysing, and constructing these research works.

I. Intelligent Forensics

Intelligent forensics is an interdisciplinary method that uses resources in a more intelligent way while utilizing technological advancements to solve a case. A variety of technologies and techniques from Artificial Intelligence, computational modelling, and social network analysis are included in intelligent forensics, which helps to focus digital investigations and cut down on the time spent looking for digital evidence. Intelligent forensics can be used both pro-actively, prior to an incident, and reactively, following an occurrence. The proactive application of intelligent forensics aims to spot threats before an incident occurs. Intelligent Forensics is currently being used by secret/military services and law enforcement agencies. Techniques like social network analysis (SNA) and Artificial Intelligence (AI) are used in Intelligent Forensics. In order to deal with the complexity of huge data sources of digital evidence, there are a number of viable intelligent forensic solutions. The solutions centre on either condensing the scope of the investigation, accelerating the investigation instruments, or utilizing intelligent forensics. instead of using queries to find data like in conventional digital forensics, intelligent forensics uses improved methods and approaches. (Irons & Lallie, 2014)

II. Application of Ai and Automation In Digital Forensic

Law enforcement organizations have been able to pinpoint important trends in a variety of crimes thanks to the impact of Intelligent Automation in Digital Forensics (Reiber,

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2018). The prospects for using Artificial Intelligence in computer forensics are identified in this section, with the discussion concentrating on the ways in which using AI and Automation might improve computer forensics investigations.

A. Representation of knowledge

A concept in AI systems is representation of knowledge and ontology. The information we want to be able to reason about is what we call as representation of knowledge, and ontology is how we formally structure that knowledge representation so that we can reason about it. It is noteworthy that representation of knowledge can be characteristics of item in the domain, how these can be processed and how the processes are applied.

In the article 'The use of Artificial Intelligence in Digital Forensics: An Introduction' by Dr Faye Mitchell it is stated that AI has the greatest potential to impact Digital Forensics since it can offer expertise to aid in the standardization of the representation of knowledge and information in the field. Even the most fundamental activities in Digital Forensics, such the interchange of image information amongst forensic imaging tools (Turner, 2005), are made more difficult by this absence of standards. This indicates that Digital Forensics lags behind generally recognized best practices. Clear advantages would result from the development of an international domain ontology for digital forensics. Set up a formal framework for communicating about digital evidence, the ability to build a large, usable case repository (Duce, Mitchell & Turner, 2007). Such a case repository would include examples of Digital Forensic investigations with known attributes and outcomes. This has proven to be incredibly helpful in other AI fields and could be effective for teaching Digital Forensic professionals as well as testing the performance of specialists, whether they be humans or AI systems. A standardized ontology may be extremely helpful in developing a uniform, reusable body of background knowledge that AI systems could exploit.

B. Artificial Intelligence and Automation

As discussed above Artificial Intelligence and Automation are making significant headway in the field of Digital Forensics. The "Evidence Analysis" stage of Digital Forensics has been highlighted by the researchers as having a high relevance for AI. Digital forensic tools with AI capabilities process objective data, analyse it, and then create strong prospective hypotheses that can be used as evidence in a court of law (Costantini et all. 2019).

1) Video-Based Evidence Analysis and Extraction in Digital Forensic Investigation:
The research carried out by Xiao, Li and Xu in 2019 proposes an Artificial Intelligence based approach to conduct through video-based evidence analysis and data extraction. In order to analyse low-quality footage, the researchers suggest a forensic video analysis framework that uses an effective video/image enhancement algorithm. For use in Digital Forensic investigations, a Closed-Circuit Television (CCTV) footage quality improvement technique based on Contrast Limited Adaptive Histogram Equalization (CLAHE) is developed. A deep-learning-based object detection and tracking system is suggested to aid in the video-based forensic investigation by detecting and identifying suspected suspects and tools from film (Xiao, Li & Xu, 2019).

2) Automated Forensic Examiner (AFE):
Fahdi, Clarke & Furnell proposes an Automated Forensic Examiner that aims to solve the sorting and identification challenge in a case using Artificial Intelligence. The techniques used here are technical competency measure, dynamic criminal knowledge base and visualization to give the Digital Forensics investigator a comprehensive understanding of the case. To find evidence, the proposed method employs an iterative method. Next, it performs associative mapping to connected occurrences, and as a result, the system produces an evidence trail. Automated Evidence Profiler (AEP) and Self Organizing Maps (SOMs) are the core components of the AFE. The growing disparity between the quantity and scope of cases requiring forensic investigation and time requirements has been successfully addressed by the suggested strategy. This solution is an effective way to address the current problems. This solution comes to the conclusion that normal Digital Forensic procedures can be automated using methods like SOM and AEP, making the entire process more cost-effective and efficient. (Fahdi, Clarke & Furnell, 2013)

3) AI Framework:
In the article 'Towards an Artificial Intelligence Framework by Actively Defend Cyberspace' by Masombuka, Grobler & Watson the techniques and methodologies for applying AI in Digital Forensics investigations and the motivation of an active defence framework is highlighted. The AI framework addresses advanced threats and emphasises on proactive measures, real time detection, active monitoring and mitigation of key threats. The article also explores innovative strategies, like the use of Artificial Intelligence (AI) systems with the ability to learn, adapt, and analyse data in real time to detect user behaviour, would help defend the cyberspace. According to the research done the proposed framework is aimed on strengthening the security backbone of an organization and illustrates the importance of combing AI and cybersecurity. The framework being presented also aims to provide the groundwork for future studies and research on the significance of defending cyberspace through AI. (Masombuka, Grobler & Bruce Watson, 2018).

4) Network Intrusion Detection:
Intrusion Detection System (IDS) is used to detect cyber-attacks or malicious activity. Artificial Intelligence is often regarded as the better method for modifying and creating IDS and plays a crucial role in detecting intrusions. Neural network algorithms are a novel Artificial Intelligence method that can be used to solve difficulties in the present day.

In the study carried out by Kanimozhi and Jacob a system is proposed to detect a specific type of botnet attacks that poses a severs threat to banking and financial sectors. Artificial Intelligence is used to develop the suggested system using a realistic cyber defence dataset (CSE-CIC-IDS2018), The proposed Artificial Intelligence-based intrusion detection system for classifying botnet attacks is strong, precise, and accurate. It is recorded with a performance accuracy of 99.97%. The newly proposed system can be used for real-time network traffic data analysis as well as for traditional network traffic analysis and cyber-physical system traffic analysis. This system can also be enhanced to reorganize other types of attacks. Kanimozhi & Jacob, 2019)

C. Pattern Recognition
Pattern recognition is a subset of AI that excels at identifying particular types or groups of data in an inquiry. Patten recognition includes image recognition and recognizing a pattern in a disk image that would suggest it is a sound file, or a pattern in an email message that suggests SPAM. Many of the strategies make heavy use of probabilistic reasoning, statistics, or both. Understanding how the human perceptual system functions is necessary for the more sophisticated and precise sorts of image recognition that may be used to locate particular types of pictures (Mitchell. 2014). Machine Learning, Artificial Neural Nets or decisions trees techniques help in Pattern Recognition.

A study carried out by Fahdi, Clarke & Furnell apply unsupervised pattern recognition to identify notable artefacts utilizing Self-Organising Map (SOM). It can be considered that SOM as a supportive method for visually interpreting and analysing data produced by computer forensic tool (Fei et al, 2005) & (Fei at all, 2006). This study highlights that the application of SOM to identify notable artefacts works well in one case but poor identification in another case. As a conclusion the study states that their experimental results display a good level of performance. The findings imply that SOM can be utilized to benefit forensic investigators, such as by aiding in the visualization of artifacts and speeding up human analytical processes. However, it has never been attempted to utilize SOM to analyse a forensic image with the sole goal of identifying significant files using metadata retrieved at the file system and application levels. (Fahdi, Clarke & Furnell, 2016)

C. Neural Network
Studies have also proved that Neural Networks can be trained to identify appropriate and inappropriate behaviour and even model the behaviour patterns of different users so that it would be feasible to alert unusual use pattern to the currently logged in user. To identify exceptions and uncover patterns of behaviour, employ machine learning

and data mining approaches. It is possible to create systems that continuously learn and enhance system performance in addition to big data analytics and high-speed computing platforms in order to stay up with shifting trends in the computer forensics industry. (Irons & Lallie, 2014)

3. Discussion
The impact of Artificial Intelligence and Automation on Digital Forensics is significant. The overall efficiency and quick recognition of patterns and other evidence is phenomenal. The efficiency and speed have enabled forensic professionals to produce leads and resolve cases with less effort, expense, and time.

Applying Artificial Intelligence and Automation in Digital Forensics also rises a few challenges.

Since Intelligent Automation enabled tools are still in development and may not always produce accurate, complete, or robust information necessary for forensic cases, the accuracy of the forensic outcome is somewhat dependent on the abilities of the human investigator (James & Gladshev, 2013). It is required to either hire highly skilled investigators or give the investigator extensive training and skill development to get around this issue.

Another problem is the use of various, sophisticated media formats, which the existing AI systems may find difficult to gather or analyse (Fahdi, Clarke & Furnell, 2013).

If any crucial information is absent from a knowledge representation, the forensic outcome may be impacted and may lead to incorrect conclusions. In pattern recognition algorithms, there is also a chance of producing a significant number of false positives and false negatives.

4. Conclusion
From the seed of a concept, cultivated by daring pioneers, developed and expanded by professionals, to its present condition, Digital Forensics has bloomed in less than thirty years. To provide the field with a strong basis for the future, many people have dedicated their time, experience, and enthusiasm. Recent trends suggest that cybercrime and the use of digital investigations are occurring in a changing and larger-scale context. There is a need to examine more effective and efficient processes and procedures in digital investigations in order to handle cybercrime in terms of identifying, gathering, recovering, analysing, and recording. Because anti-forensic strategies will keep getting more advanced, new technologies are required for better Digital Forensics. Although the application of Artificial Intelligence and Automation in Digital Forensics is still in its infancy, it has a lot to offer the field.

This review paper identifies potential opportunities provided by applying Artificial Intelligence and Automation principles and procedures to Digital Forensics

and, as a result, applying intelligent techniques to digital investigation and address the issues of the larger and more complex domains where cybercrimes occur. This study identified and analysed a number of applications and frameworks for combining Artificial Intelligence and Automation with Digital Forensics. The study also reveals the potential impacts and challenges of incorporating Artificial Intelligence and Automation in Digital Forensics.

Cost reduction, improved efficiency and speed of forensic investigations, accurate data and information processing and increased probability of solving higher number of cases in limited amounts of time is the impact of Artificial Intelligence and Automation in Digital Forensics. We can see that that these different ways have simplified the life of a digital forensic investigator. Additionally, I believe that there is a need to increase public awareness of the use, applicability, and effects of Automation and Artificial Intelligence in the field of Digital Forensics. The general public, including individuals, groups, manufacturers, law enforcement and cyber security experts, needs to be made aware of these benefits.

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Acknowledgment

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Implementation of Autonomous Robotic Arm for Nerenchi Board Game

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Abstract: *Sri Lankan board games have a special place in Sri Lankan traditions. Peralikatuma,Olinda Keliya and nerenchi are some example for these board games. Among these games, nerenchi is one of the oldest board game and it is even mentioned in Sri Lankan ancient textbooks. Nerenchi is a board game that can play up to two players. Playing board games like nerenchi helps us to improve our soft and tactical skills. With the improvement of social media and video games, the new generation distanced from these games. Because of this old folk games like nerenchi on the brick of existence. It's urgent to use new technologies to attract the young generation to these games. A web-based game that can play nerenchi game up to 2 players introduced to overcome this issue. UI/UX of that web-based game is not up to date because of that it's difficult to attract the new generation. This paper discussed a robotic solution to automate the nerenchi board game. The proposed system consists of two main parts. They are smart nerenchi board and robotic arm. Smart nerenchi board consists of 24 IR sensors which are used to detect the nerenchi pieces on the board and are powered by Arduino mega board. A fully 3D-printed 5 DOF robotic arm was used for this system. Arduino Mega board is also used in the robotic arm to control the function of the servo motors. The proposed system going to test in laboratory conditions and compare the detection accuracy with the image processing approach.*

Keywords: *Nerenchi, Robotic arm, Sensors*

1. Introduction

Sri Lanka is one of the very few countries that has a very vast and rich cultural diversity. The traditional culture of Sri Lanka is very unique and therefore contributes to the Sri Lankan identity. This culture contains many types of customs and rituals, which date to more than twenty-five centuries and were handed down from generation to generation. Furthermore, Sri Lanka is enriched with rich artistic tradition, with distinct creative forms such as rituals, visual arts, folk games, and folk music and dance (Meththananda and Hettige, 2015).

Folk games of Sri Lanka take a special place in Sri Lankan culture and are unique to the country. Most of these traditional games connect with people's life during the Sinhala and Tamil new year season. Not only that but also, these games have a rich history of more than two thousand years and some of the historical writings such as Mahawanshaya and Thupawanshaya provide evidence(Meththananda and Hettige, 2015). Furthermore, these games can be played both indoors and outdoor. Gal kireema, Neranchi, Pancha dameema, Olinda keliya (Muthu keliya), Wala kaju gaseema, Lunu paneema, Onchili padima, Porapol gaseema are some of the popular examples for Sri Lankan folk games.Among these games,Nerenchi and pancha dameema are indoor games while Olinda keliya (Muthu keliya), Wala kaju gaseema, Lunu paneema, Onchili padima, Porapol gaseema are outdoor games. These games are designed in a simple way that all generations could enjoy together. In addition, the equipment that are used to play these games are mainly made from natural materials such as fruit seeds or wood.

Board games are indoor games that are very popular around the world. Playing board games helps us to spend our leisure time in a more meaningful way. Playing these games especially helps children develop their soft skills like creativity, adaptability, leadership, teamwork, strategies and tactics, and communication skills. Chess, Monopoly, checkers, and Go are some examples of popular board games.

Sri Lankan folk games also have consisted of unique board games. Pancha keliya, Olinda keliya, and nerenchi are examples of these games. Among them, nerenchi is one of the oldest Sri Lankan board game. Nerenchi even played in the Anuradhapura kingdom time. Nerenchi can play up to two players. Nerenchi is a highly competitive strategic game. Nerenchi's game design is similar to Nine Men's Morris.

Although these traditional games are popular among the old generation, with the improvement of technologies like social media and video games the younger generation is distanced from these traditional games. Board games like nerenchi build the thinking and learning abilities of children. And these games are designed to relax our minds. But on the other hand, video games only teach violence and impatient. Addiction to social media and video games

leads to mental health issues among school children in Sri Lanka. Depression is one of the main mental health problem common among school children(van den Broek *et al.*, 2021). The main cause for this issue is that the new generation is distanced from our cultural and traditional values. Nowadays board games like nerenchi have a threat of going extinct.

To overcome this issue various web-based video games have been designed. Because of the poor UI/UX and game design, those systems failed to attract new generations to the platform. It's urgent to involve new technological aspects to solve this problem.

Robotics and automation is one of the trending area in the field of computing. Nowadays Robotics and automation have been used in every field. The robotic arm is one of the key aspects of robotics. The robotic arm is a mechanical component that is built to simplify a set of tasks that needs high accuracy. Robots are used in both domestic and industrial environments. Robots can perform tasks in intensive environments where humans couldn't work.

This paper going to discuss the design and implementation of the robotic arm to automate the nerenchi board game. This system uses IR sensor-based technology to detect nerenchi pieces in the nerenchi board. Arduino mega with three multiplexers used in smart nrenchi board to control the functions of the smart nrenchi board. Three MG996R Servo motors and Three SG90 Micro Servo motors are used in the robotic arm. And Adafruit 16-Channel 12-bit PWM/Servo Driver is used to control all the motors in the system. Arduino mega is used in the robotic arm also to control the motion of the robotic arm. After detection, the robotic arm pickup nerenchi pieces and moves them on the board according to the nerenchi rules. This system can use to attract a new generation to these old Sri Lanka folk games. Also, this system can be used in hotels and restaurants to promote Sri Lankan cultures and traditions among tourists around the world.

The paper is structured as follows. Section 2 describes the overview of nerenchi game. Section 3 describes related works and technologies. Section 4 presents the system design. section 5 describes the results and evaluations of the system. section 6 of the paper presents the conclusion and the further work of the project.
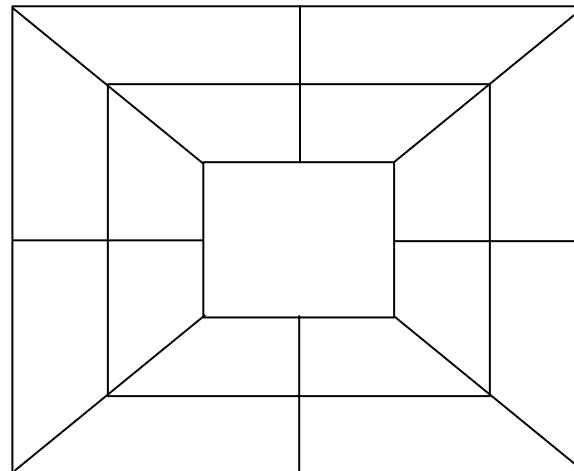
I. Overview of The Nerenchi Game

Figure 1. Nerenchi Board

Nerenchi is a two-player strategic game. Nerenchi board was designed with diagonal lines joining the corners of the squares as shown in Figure 1. Wood is mainly used to build nerenchi board.Nerenchi board design is a bit similar to the Mill and nine Morris game. When playing Nerenchi it has two main phases: placing nerenchi pieces and moving nerenchi pieces. A brief description of each phase is given below.
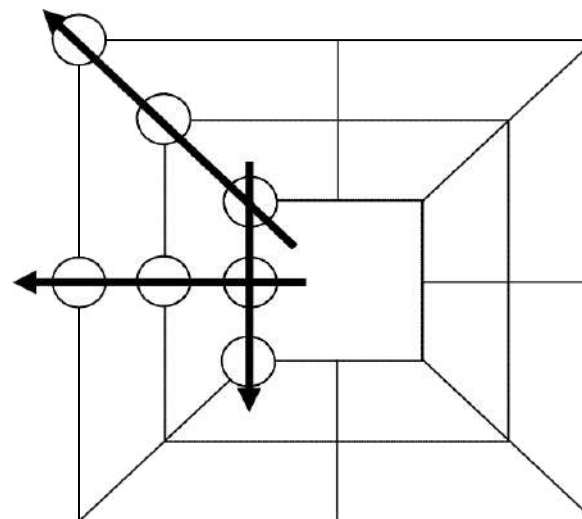

Figure 2. Placing Nerenchi Pieces

A. Placing Nerenchi Piece

In the first phase of the game, players have to place nerenchi pieces on the board. Players need to place 22 nerenchi pieces on the board with the 12 pieces that each player has. If one player successfully placed three nerenchi pieces on a straight line horizontally, vertically, or diagonally, that player will get a bonus called "Nerenchi". This phase continues until the nerenchi pieces on the board reach 22 or one player places all 12 nerenchi

pieces on the board. After that second phase of the game started.

B. Moving Nerenchi Pieces

After placing nerenchi piece on the board, In the next phase players are allowed move nerenchi pieces on the board vertically or horizontally along the line to an adjacent joint but not diagonally. In this phase, players allow capturing other players' nerenchi pieces. The player is allowed to capture nerenchi piece of another player if that player gets a "Nerenchi" reward.

In This phase, it decides the winner of the game. To win the game a player must capture all nerenchi pieces of the opponent or block all the possible moves of the opponent.

2. RelatedWorks

This section of the paper discusses the technologies and concepts that are related to this project.

(Bandaranaike and Hettige, 2021) developed a CNC model to automate the "Nerenchi" board game. In this project, they used IR sensors to detect nerenchi pieces. A 24-bit array has been used to store the position of the object on the board. It generates a new 24-bit array when a new object is placed on the board. Then that array is sent back to the system and the system uses the CNC model to place the object in the relevant position. In this project, they used Arduino mega as their main microcontroller.

(Meththananda and Hettige, 2015) implemented a computational model for "Nerenchi" game by using 2 matrices. One matrix for controlling the user errors and another matrix for set rules. They developed this system as a web-based application using the .NET framework and MySQL They developed human-human mode and human-computer as their main two-game mode. They used the PROLOG engine for human-computer mode.

(Goonatilleke and Hettige, 2021) in this research they implemented a robotic arm to automate traditional drums in Sri Lanka. Sri Lankan drums are one of the key components of Sri Lankan tradition. This system consists of six main modules. They are the power module, processing module, solenoid control module, servomotor controller module, input module, and display module. In this system, they used two robotic arms.

(Shuang et al., 2017) developed a robot that can play a chess board game. They developed the game engine for the system using C language and LabVIEW. In this system, they used image processing technologies to

recognize chess pieces. They used STM32 to image processing technologies and Arduino for the mechanical part of the system. Image processing errors and positioning inaccurate are the main downsides of this system.

(Srivatsan, Badrinath and Lakshmi Sutha, 2020) developed a robotic arm using raspberry pi to automate chess board game. OpenCV library is used for image processing and canny edge detection is used as the main image processing technique. A 4-DOF robotic arm is used for this system. In this system, TensorFlow deep learning framework has been used with image processing technologies to identify the chess objects on the board.

(del Toro, Robles-Algarín and Rodríguez-Álvarez, 2019) designed a 4-DOF robotic arm for automating chess games. Solid work was used to design the robotic arm. convolutional neural networks are used for the detection of the chess pieces on the board. Kanade–Lucas–Tomasi method is used in this system for image processing. Stockfish open-source game engine used in this system. Arduino is used as the main microcontroller to control the robotic arm.

(Kopets et al., 2020) developed a robotic system to automate the Russian checker's game. An unsupervised learning algorithm called Alpha Zero was used to develop the game engine of the project. In this project, they used a magnetic sensor-based system to identify the checker pieces instead of using image processing. The accuracy of recognizing objects on the board is higher in this system than in the systems that use image processing techniques.

(Chen et al., 2020) developed a robotic system to automate Chinese chess. In this system, they used a 5-DOF robotic arm, and forward and inverse kinematics are used to control the robotic arm. MATLAB is used for image recognition. convolutional neural networks (CNNs) are used for the recognition of chess pieces.

(Al-Saedi and Mohammed, 2015) developed a 5-DOF robotic arm to automate the chess board game. "SharpChess" open-source game engine that is used for this system. The downside of this project is that robot manipulator accuracy decreases over time.

3. SystemDesign

The main components used in the implementation of this project are:

- Arduino Mega

Two Arduino Mega boards are used in this system. One Arduino Mega is used for the smart nerenchi board to control the function of the IR sensors and multiplexers.

And one Arduino Mega board to control the servo motors of the robotic arm.

- IR sensors

In this system, 24 IR sensors are used to detect the nerenchi pieces on the nerenchi board.

- Adafruit PWM/Servo Driver

In this system, we used Adafruit 16-Channel 12-bit PWM/Servo Driver to control the Three MG996R Servo motors and Three SG90 Micro Servo motors used in the robotic arm.

- CD4052B Multiplexer

All the data which are taken from the IR sensors are sent to this IC and it multiplies the data inputs.

Figure 3. System overview

This system has two main parts.

1. Smart nerenchi board

2. Robotic arm

A. Smart nerenchi Board

Figure 4. Smart nerenchi board

The smart nerenchi board was developed using 24 IR sensors and with three CD4052B Multiplexers.24 IR sensors are used in nerencchi places on the nerenchi board for the detection of the nerenchi pieces when they are placed on the nerenchi board. The data taken from IR sensors are sent to the Multiplexers. The multiplexers are used in this system to multiply the output of the IR sensors. Here multiplexers give relevant feedback through 8 channels. Nerenchi board consists of two layers. one layer to hold nerenchi pieces and the other layer to attach the 24 IR sensors.

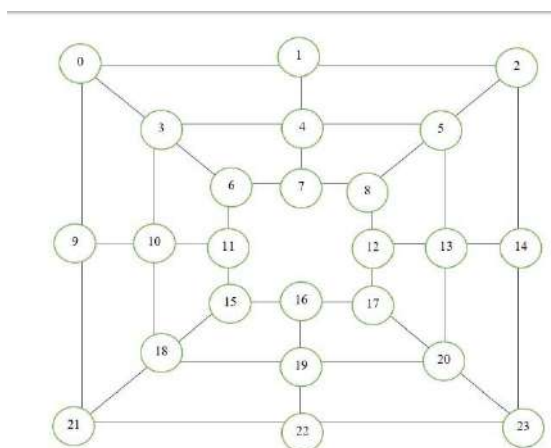Figure 5. Layer 1

Figure 6. Layer 2

Figure 7. Smart Nerenchi board array Design

As shown in figure 7 nerenchi places on the nerenchi board are numbered and taken as a location array. This array changes according to the way nerenchi pieces are placed on those nerenchi places on nerenchi board. If there is no nerenchi object detect6ed by the IR sensors, then the array value is 0. for example, when no objects are on the board the location matrix is;
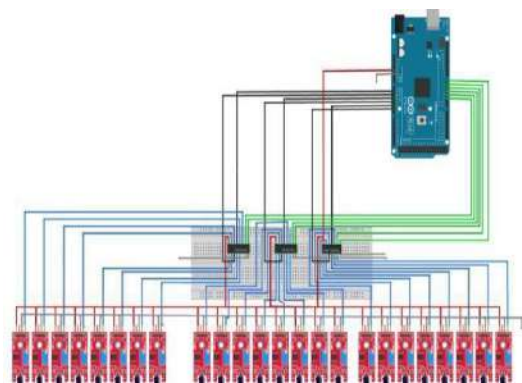
Location matrix: [0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0]

Figure 8 . Circuit diagram Of Nerenchi Board

B. Robotic Arm

Figure 9. Robotic Arm

A fully 3D printed 5 DOF robotic arm is used in this system. Three MG996R Servo motors have been used for the waist, shoulder, and elbow of the robotic arm. Three SG90 Micro Servo motors have been used for wrist roll, wrist pitch, and gripper of the robotic arm. Adafruit 16-Channel 12-bit PWM/Servo Driver is used to control all the motors in the system. The robotic arm is powered by an Arduino Mega board which is used to control the motions of the robotic arm. In this system, Inverse kinematics is used to determine and calculate all the possible sets of joint angles that could be used to attain this given position and orientation.
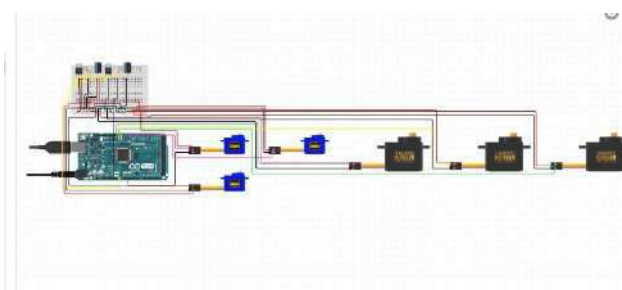

Figure 10. Circuit diagram of the robotic arm

4. System in Action

When the IR sensors on the board detect a nerenchi piece on the board the data collected by IR sensors are sent to the computer. Then it generates a 24-bit array according to the position of the nerenchi piece. Then the computer process and generates a new 24-bit array with a new location and sent back to the system and then the robotic arm moves the nerenvhi pieces according to that array. The robotic arm can perform 3 tasks according to the array.

- Move a new nerenchi piece onto the board

- Remove an existing nerenchi piece from the board

- Replace an existing nerenchi piece with another nerenchi piece

Here, the Inverse Kinematic algorithm is used for the movement of the robotic arm.

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5. Conclusion and Further Work

With the improvement in technology, Sri Lankan traditional games are on the verge of existence. Especially the traditional board games like Nerenchi. Playing these board games helps us to develop our creativity, adaptability, leadership, teamwork, strategies and tactics, and communication skills. Addiction to social media and video games ruins much of young life. It's urgent to bring old folk games back to life. By using technology, we can bring back our generation towards these old folk games.

this proposed system, it uses IR sensors instead of image processing techniques to identify the objects. Arduino-powered 5 DOF robotic arm is used in this system to move the objects on the game board.

For Further work need to add AI algorithms to the system so that it can apply more advanced game tactics when playing with a human. The testing of the system going to do in laboratory conditions and the result will compare the detection accuracy with the image processing approach.

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(van den Broek *et al.*, 2021)

American Sign Language Recognition Using Deep Learning

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Abstract: *American Sign Language (ASL) is a visual gestural language used by the deaf community for communication. There exists a communication gap between hearing-impairedhearing and the normal people because most normal people do not understand the sign language. Conversations with the hearing-impaired people becomes more difficult as most of us do not know the sign language. Hand movements are one of the most powerful nonverbal communication methods which uses both non-manual and manualcorrespondence. ASL-to-text ASL to text interpreting technology using hand gesture recognition could fill up this communication gap. Recently, the hand gesture recognition systems received a great attention and many researchers have been doing studies on the methods for hand gesture recognition for many different purposes. Sign Language recognition is one main purpose among those purposes. Among these the Finger Spelling method is a very interesting research problem in computer vision which has being addressed for years with different kinds of applications in various domains. Inthis paper a survey of existing hand gesture recognition systems and sign language recognition systems are presented for the recognition of Static Finger Spelling method in the American Sign Language. This sign language recognition can be achieved by using sensor- based or vision-based approaches. In this paper, both these approaches are reviewed along with the background of the problem and the pros and cons are also discussed algorithms.*

Keywords: *Sign Language Recognition, Hand Gesture Recognition, American Sign Language*

1. Intorduction

Each individual utilizes a language to communicate with others but there exists a communication barrier between the hearing impaired and speech-impairedspeeche and normal people. When it comes to the conversations with hearing-impairedhearing mostly, they use the sign language to express their thoughts and to understand what the other person says. Hand movements are one of the most powerful nonverbal communication methods which uses both non-manual and manual correspondence. Conversations with the hearing-impaired people become more difficult as most of us do not know the sign language. Sign language is a visual language and it mainly consist of 3 components. They are Fingerspelling, Sign vocabulary and non-manual features. Among these the Finger Spelling method is a very interesting research problem in computer vision that has been addressed for years with different kinds of applications in various domains. In this paper, a critical review has been done to identify existing systems that have been developed using many different technologies on the purpose of hand gesture recognition and sign language recognition.

Furthermore, a systematic review is presented on computer vision techniques as well as other techniques which are used to the utilize the Finger-spelling method and the American Sign Language (ASL) to translate the sign language into text in . This proposedg system aims to develop algorithms and methods to correctly identify a sequence of demonstrated signs and then translate them into its meaning. Several features of sign language must be obtained in order to recognize a sign. Manual markers such as handshape, hand orientation, location and movement expressing lexical meaning are some of those necessary features. This system will not only be used as a communication tool between hearing impaired people and normal people, but also as a system for self-learning assessment. Deaf children will be able to use this system as a self-assessment tool in learning the ASL alphabet.

The rest of the paper is organized as follows. Section 2 presents the background information on the deaf community, sign languages and ASL. Section 3 gives a literature review to study some of the existing systems which uses computer vision-based techniques as well as other techniques on hand gesture recognition and sign language recognition. Section 4 gives the proposed solution to the problem and the following sections contain the methodology, results and the conclusion together with future developments.

2. Background

A. Deaf Community

(Anon., 2021a) Any person who is having problems in hearing and talking like a normal person can be categorized into the deaf community. This community shares a common language to communicate with others. That is called as the Sign Language (SL).

B. Sign Language

(Perera and Jayalal, n.d.) Sign Language is a visual language that uses hand gestures, facial expressions and other body parts like mouth and eyes to convey a message. As mentioned above, there are three main components in sign language. In Finger-spelling method, a word is spelled out using hand signs character by character whereas the Sign vocabulary contains an entire gesture for one word. Non-manumanualtures use tongue and facial expressions to convey the message to the other person. Among these, the finger spelling method uses an alphabet which represents letters by hand signs. All around the world there exist more than 100 different sign language alphabets including Sinhala Sign Language (SSL), American Sign Language (ASL), (Hosoe, Sako and Kwolek, 2017) Japanese Sign Language (JSL) and (Association for Computing Machinery and International Conference on Intelligent Computing and Applications (8th: 2019: Melbourne, n.d.) Thai Sign Language (TSL). American Sign Language is one of the most famous sign languages among these.

C. American Sign Language (ASL)

ASL is a complete, natural language which is the primary language of Northern American deaf community. (Anon., 2021b)ASL has the same linguistic properties as any spoken language, but grammar may differ from normal spoken English. The ASL alphabet is shown as Figure 1.
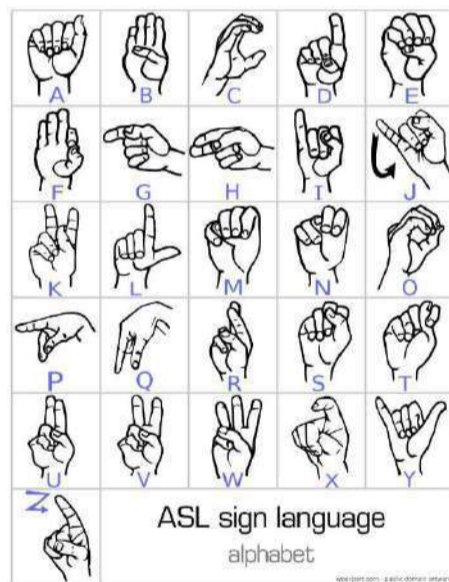

Figure 1: ASL Sign Language Alphabet

3. Literature Review

(Chen et al., 2014) Sign language recognition is one of the widely used applications that come under the hand gesture recognition technology. This hand gesture recognition has gained a wide research interest for years now. There have been many publications related to this topic. When it comes to the sign-language recognition systems, there are some prominent works done by researchers which helps this study in many ways. (Shukor et al., 2015) Hand gesture recognition technology can be divided into main two categories: wearable data glove method and computer vision-based method.

A. Wearable Data-glove Method

Using a wearable data glove is one of the most used methods in the early days. (Oudah, Al-Naji and Chahl, 2020) Sensors are used to capture the position and motion of the hand. Using this glove technique, the exact coordinates of finger locations and palm, exact orientation and configuration can be obtained easily. These each data glove is outlined with 10 flex sensors, two on every finger and those sensors recognize the bending of eacheach finger and transmit the signals to the microcontroller. (Shukor et al., 2015) In this data glove technique, the flex sensors function as variable resistance sensors, it means that when we bend our fingers the change of the resistance is indicated by the flex sensors. Because of that this framework requires less computational force to recognize the wanted hand gesture.
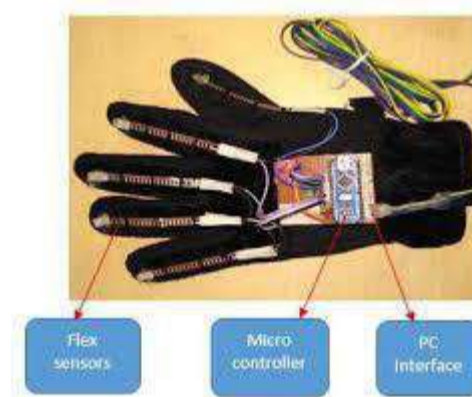

Figure 2: Wearable data-glove

(Oudah, Al-Naji and Chahl, 2020) This data glove is highly suitable in recognizing both sign motions and fingerspelling which include both dynamic and static signs. However, these gloves cost more money as they were made using high priced sensors. Also, the user had to wear the glove and needs to be physically connected to the computer to keep the interaction between the user and the computer. (Aryanie and Heryadi, 2015) It is possible to make less expensive gloves using less sensors, but they are more vulnerable to noise and will give less accurate results in the sign language interpretation process.

In (Wang and Popović, n.d.), a glove with different color markers is used to track the movement of the hand and capture the gestures, shown in Figure 3. This method has been called "Color-based recognition using a glove marker". This glove consists of 20 patches colored randomly with a set of distinct 10 colors. The different color patches on the glove enable the camera sensors to track and detect the location of the fingers and palm. This technique is sufficiently distinctive that the system could reliably recognize the movement or the sign of the hand from a single frame. (Wang and Popović, n.d.) Compared to the

data glove method this method is way cheaper but wearing a glove limits the degree of natural interaction between the user and the computer.

Figure 3: Glove used for the color-based recognition using glove marker

B. Computer Vision-based method

1. *Finger Segmentation method*

In (Chen et al., 2014), the authors detect the hand gesture inputs using a method called the "finger segmentation method". In this finger segmentation method, the images are captured with a normal camera and then hand is detected from the background using background subtraction method. All the images are taken under the same conditions and the background is identical. The hand detection process outputs a binary image where the white pixels indicate the hand region, while blacblackels indicate the background. Palm point is found by the distance transform method and palm mask is drawn with the help of the palm point and the wrist points. Next, the fingers are discovered and segmented using the palm mask. (Tay et al., n.d.) Using a labeling algorithm finger regions are marked, and the center points of fingers are detected. Based on the segmentation results, a simple rule classifier is then used to get the recognition done. Using this classifier, the hand sign shown to the camera is recognized according to the content and the number of fingers detected by the segmentation process. (Chen et al., 2014) As the experimental results show, this approach performs well in the real-time applications but the performance of it depends on the result of the hand detection.

2. *Multi Feature Fusion*

Mainly hand gesture features fall into 2 categories: the apparent-based model and the 3-D hand gesture model. In (Liu, Zhang and Zhang, 2012), a hand gesture recognition technology is introduced using the apparent-based model approach. In apparent-based model methods the images are directly used for the hand gesture identification. Using the multi-feature fusion method, the recognition results are improved by extracting the angle count, non-skin color angle, skin color angle in combination with 'Hu invariant moment features' of the large regions of the hand for the

target image recognition and for the training of the sample. First, the extracted images from the camera are transformed from RGB space into HSV space for skin color detection. By using the HSV space the hand shaped region can be located effectively. (Liu, Zhang and Zhang, 2012) Next the extraction of the contour of the hand gesture region is obtained comparing to ensure the integrity of the gesture. In the obtained contour area, the center point, radius and the angle of the connection points in the edges are computed and then feature vector is selected. Multiple feature fusion makes the feature analysis data of the extracted images more comprehensive and more differential between the feature values of different hand signs. After extracting extracting features of each test imagimage, value of each feature is matched by Euclidean distance with multi-feature fusion method. Then, the system matches the angle count of hand sign images and selects the possible images through the threshold filter. Skin color angle and non-skin color angle values are matched next through the threshold selection in the same way and further narrow the selection belongs to the hand sign. Finally, the system obtains the result through one of the above 3 categories by matching the Hu variant moments features and then detedetermining classification of the hand sign image.

3. *Scale Invariant Feature Transform*

In (Perera and Jayalal, n.d.), a model is presented which is developed combining CNN (Convolutional Neural Network) and SIFT (Scale Invariant Feature Transform). This model is capable of achieving higher accuracy in sign language recognition using less training data. This proposed system consconsists main 4 stages: data acquisition, image preprocessing, feature extraction, classification and displaying text. As a low-cost implementation, a simple web camera is used for capturing the image. When the images are captured using the web camera, they are preprocessed to enhance the features. Captured RGB images are converted into HSV color space in order to enhance the features. Then a mask is applied to separate the hand region from the background. In the feature extraction stage key points on the preprocessed images are localized and SIFT feature descriptors are generated for each key point, as shown in the figure 4.

Figure 4: SIFT key point mapped on binary image

(Mahmud et al., n.d.) The sizes of the descriptors differ from each other, because of that a uniform size vector is generated using K-means clustering. To scale the variations

of the hand, this result is combined with a feature map from CNN to improve the robustness. Then the hand sign images are classified into relevant classes. The classification model consists of a channel from CNN and another channel from the SIFT and the final fully connected layer will concatenate both vectors from the CNN and SIFT layers to generate the output of the gesture recognition model. Then the classifier gives a gesture ID to the image and the process of predicting gesture is done by mapping the gesture ID based on the predefined gesture database. When the mapping is successful the relevant text for the sign input is displayed.

4. Solution

There are few main identified problems of this research. They are the communication gap between the hearing-impaired people and the common society, and the lack of opportunities for the disable children to learn the American Sign Language. So, the proposed system of this research will give solutions for these problems.

The final deployment of this proposed system is a mobile application which has the capability of translating the captured sign language gestures into text. This mobile application will bridge the communication gap between the disabled persons and the common society. These days the mobile phone have become an essential part of the daily life of every person. So, the most suitable solution for a communication problem like this will be a mobile application. The disabled person only has to perform the gestures in front of the camera of the mobile phone. The app will capture the images from the video feed and preprocess them using the computer vision techniques. Then these preprocessed imaged will become the inputs for the CNN model. The trained model will classify the images according to the alphabetical letters and map with the corresponding letter after the recognition. Then the translated letters will be displayed on the mobile screen. The users can create words as well as sentences using this application. Using this application, disabled people will also be able to communicate with others freely at any place if they have the mobile phone with them. If someone's intention is to learn the American Sign Language, they can use the front camera of the mobile phone and perform the gestures in front of it. Then the mobile app will translate the gesture and display the corresponding letter for the sign. In this way, the proposed system can provide the solutions for the core problems of the deaf and speech impaired people.

5. Methodology

This proposed system consists of main 4 stages: data acquisition, image preprocessing, feature extraction, classification and displaying text. Data acquisition is done by getting the inputs, or the signs into the system using the camera of the device. Then the image preprocessing, feature extraction and the classification of the signs are done. Finally, as the output of the system the translated text of the signs is displayed.

A. Dataset

A dataset which consists of the letters in the ASL alphabet is created. 2000 images were captured for each individual letter in the ASL alphabet and they are divided into training and test datasets.

Figure 5: Dataset images

B. Input

The main input of this system is the images of the hand signs which are captured by the mobile camera. As this system is based on the American Sign Language there are basically more than 26 sign inputs. In the initial stage the proposed system will be implemented on these signs and later on with the modifications and add-ons, the number of inputs will be increased. Numbers will be represented by using some other signs and another sign will be used to switch between numbers and characters.

Figure 6: Input image

C. Process

When the mobile application is opened, the user is asked to choose from the options given in the application. Then the hand gesture recognition will be done by the mobile application using the developed CNN model. Then the classified signs will be mapped to the corresponding letters. Finally, the words which are spelled using the ASL finger spelling method will be translated into ordinary English words and the output will be given as sentences in the text box.

D. Output

The output of the system is the English alphabet character which is translated using the input sign image. As we use the ASL Finger spelling method in this system the output will be given letter by letter. Adding those letters sentences will be generated and it will be displayed by the system. When this system is used as a learning tool learning sable people, they can choose the learning option and select the letter or the word that they wish to learn using the system and practice it with the help of this system.

6. Result and Discussion

Early days the sign language recognition was done by using the data glove technique. That technique was very costly because those gloves were made using expensive sensors.

So that, researchers tend to search cheaper ways of fulfilling this need. Computer vision-based techniques were the best option found. Using techniques such as Finger Segmentation, SIFT, HMM, CNN and Multi-feature Fusion the above task could be done using just a web camera as hardware. Not only that, when the glove techniques are used, the user had to stay physically attached to the system. Using the computer vision-based techniques it was not necessary stay attached to any hardware devices. As we can see, the drawbacks and the limitations that existed in the wearable glove techniques could have been overcome by the computer vision-based techniques with the development of the new technologies and research. When it comes to the computer vision-based systems, above we have mentioned several systems which uses feature extraction, segmentation, and CNN techniques. When we carefully analyze all these techniques, advantages and the theitation can be listed down as follows.

As for now the developed model for the above-mentioned purpose works really well and translates the ASL alphabet letters accurately. Figure 8 shows one of the translated letters from the developed system and in Figure 7 the accuracy graph of the developed model is shown.
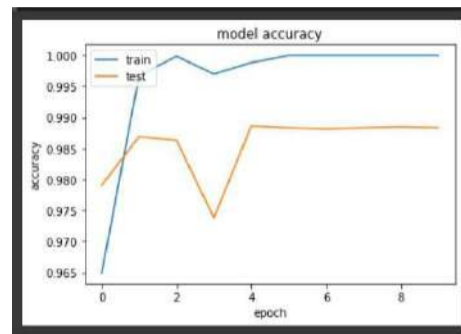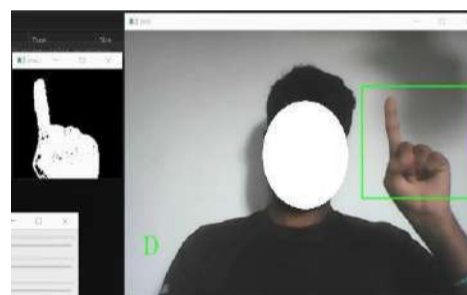

Figure 7: Accuracy graph of the developed model

Figure 8: Translation from the developed system

7. Conclusion and Future Works

In this paper, we did a critical review on the existing sign language and hand gesture recognition systems, and we compare and contrast the topics relevant to the sign language recognition systems, different hand gesture recognition models, pros and cons of each model and various techniques used in this relevant research area. After analyzing all these different kinds of methods and techniques closely we can state that the SIFT-CNN technique performs better than others. SIFT-CNN sign language recognition system has less drawbacks and more advantages when compared with other systems. When it comes to the system, we are developing using the above-discussed aboveods and techniques, an android device that we use in our daily life will be more than enough. This system will be able to address the above- mentioned problems as it shows more pros than cons as well as good results. Current datasets are developed only using 3 persons hand gesture images. In the future we will be using more images from many different persons and train the model more accurately. Also, this system will support more than one language and the users will be able to translate ASL into any language they wish.

Technique	Advantages	Disadvantages
Hidden Markov Model (HMM)	Can use for both static and dynamic recognizing, faster, efficient	Need large amount of training data, higher number of parameters used
Convolutional Neural Network (CNN)	Better performance and higher accuracy in achieved, a sub-network improves the classification accuracy, data overfitting is avoided	On higher level dynamic features the classifiers need to improve more.
Artificial Neural Network (ANN)	For the performance the illuminations and complex background affects more	Need to work in hybrid systems (HMM with ANN or CNN with ANN)
Adaptive Probabilistic Model	Can achieve better results with limited power and processing time for the embedded system applications	Due to the multi camera usage the accuracy needs to be improved

Table 1: Advantages and limitations of gesture recognition techniques

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Smart Reading Chair Design by using Kansei Engineering

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Abstract: *Reading is a fun activity that many people engage in, whether for an exam, leisure, or to gain knowledge on a specific subject. Because reading usually takes a long time, the reader should be as comfortable as possible while reading. A reading chair is an essential piece of furniture to have. As per our research findings, there are numerous reasons why someone should have a reading chair in his or her reading room rather than sitting in alternative ways such as standing or lying down on mats. The methodology used is document analysis and questionnaires with 192 respondents. Furthermore, the research indicates that backache is a common problem for avid readers and people who sit for long periods and is strongly related to their posture. According to research, Kansei Engineering is a method for translating consumer Kansei into product design elements. According to this study, Kansei engineering translates customers' psychological needs and feelings into the design of products and services. This technique will allow designers and manufacturers to incorporate Kansei into product design to gain a competitive advantage. Our research paper proposes a smart reading chair design based on Kansei Engineering's fundamental principles and methods, which provided scientific guidance for designing a chair to meet consumers' emotional needs.*

Keywords: *Kansei Engineering, Kansei word, Smart reading chair, Product design*

1. Introduction

Reading is an age-long habit of most people and whether reading for an exam, for leisure or simply reading to gain knowledge on a particular subject, reading is a useful and fun activity that many people engage in. According to the online survey conducted by Gfk with over 22,000 consumers aged 15 or older across 17 countries, it shows that 30%of the international online population read books every day or most days. Spain and the UK each account for 32%, followed by China with 36%. As a result, if daily readers and those with a weekly reading habit are added, the international total rises to 59%, with China leading the pack with 70%, followed by Russia with 59% and Spain with 57% (Majority of internet users read books either daily or at least once a week, 2022).

Because reading usually takes a long time, the reader must be as comfortable as possible when enjoying the reading material. A reading chair is an important furniture to have. There are several reasons why someone should own a reading chair instead of sitting on the floor, standing, or lying down on mats while reading. A common problem faced by avid readers and people who sit for long periods of time is backache, which is strongly related to their posture while sitting. A good reading chair will protect the reader's neck and reduce the strain on the neck to prevent aches after prolonged sitting. In today's world, it is common for people to suffer from low back pain caused by sitting. In adults, 60% experience low back pain because of sitting. A lower back injury is most commonly accompanied by pain in the buttocks, thighs, or legs. This pain is exacerbated by flexion and sitting, which aggravates the condition. (Delitto et al., 2012).

It has been reported in numerous studies that the design of furniture plays a significant role in determining the pressure at the seat pan interface when considering posture and chair design. According to this study, differences in chair design affect pressure at the seat pan/thigh interface by affecting trunk-thigh angle and the use of armrests (Vos et al., 2006).

The objective of the study is to design a smart reading chair while meeting the user requirements by applying the Kansei Engineering (KE) approach considering the human feelings or emotions of users. The Kansei Engineering strategy was founded 35 years ago at Hiroshima University, and it converts customer psychological feelings into design elements (Kalansooriya, 2016). Kansei Engineering develops products based on consumer demands and feelings. There are four points concerning Kansei engineering;

i. In terms of ergonomics and psychological evaluation, how to grasp the consumer's feeling (Kansei) about the product
ii. how to identify the design characteristics of the product from the consumers feeling
iii. how to build Kansei Engineering system as an ergonomic technology
iv. how to adjust the product design to the current societal change in people's preferences.

Section 2 of this paper deals with the related works on smart chair designing, that identify the Kansei words for the proposed system. Section 3 presents the methodology of the proposed smart chair that involves the Kansei Engineering principles in its approach. Section 4 presents the results of

the conducted study and section 5 provides the discussion and conclusion section of this paper.

2. Methodology

The study's methodology primarily focuses on the Kansei design principles. In order to create a product that will make people happy and satisfied, Kansei Technical (KE) integrates the engineering discipline with human feelings and emotions (Kansei term).
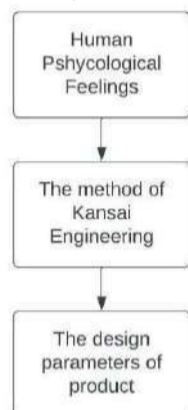

Figure 1. Diagram of Kansei Engineering Method

A chair design workflow using forward quantitative inference is developed, as well as a chair modeling design framework based on Kansei engineering. It is appropriate for the conceptual design stage of chairs and can be used in conjunction with examples of modern chairs to have a thorough understanding of chair modeling designs based on Kansei engineering. (Yong-Jun, Zhong-Feng and Rui-Lin, 2014).
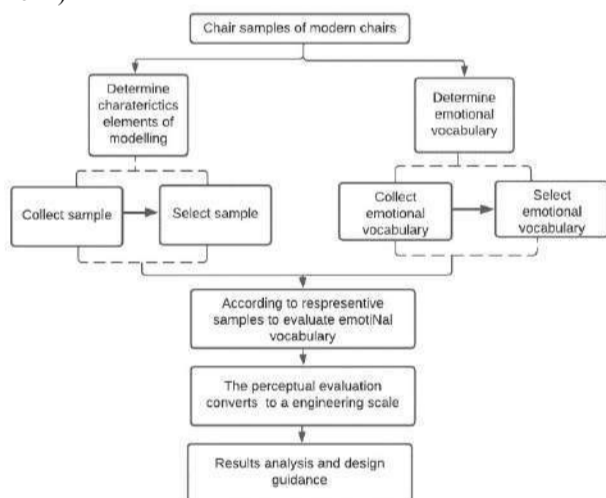
Figure 2. Framework of Chair shaping design based on Kansei engineering

The modeling is broken down into a number of independent parts, such as the backrest, seat, armrest, leg, and so on, using the structure of the chair as a starting point. Additionally, each item is broken into distinct categories based on defining characteristics. For example, the backrest item was separated into linear, curved, line and plane, plane,

and curved surfaces categories. (Soewardi and Dindadhika, 2018).

The majority of the samples of modern design chairs are gathered from furniture stores, periodicals, the internet, books, and other media. In the process of gathering emotional vocabulary, one hand was primarily used to locate pertinent literature on modern-style chairs in domestic and international sources; the other hand was used to compile emotional vocabulary specific to modern-style chairs from sources such as furniture-related books, websites, magazines etc.

Then, using an expert method, it preliminary picked, edited, and classed the emotional image vocabulary. Senior furniture designers and professional furniture experts are the professionals, allowing for the features of the modeling of the contemporary chairs. As a result, it uses the chair's disassembly to identify some preliminary characteristic elements. (Yong-Jun, Zhong-Feng and Rui-Lin, 2014).

3. Experimenral Design

A psychological term known as "kansei" (Jindo, Hirasago and Nagamachi, 1995) refers to the integration of customers' sensory perceptions (sight, hearing, smell, touching, and so on) and cognition induced by the size, color, functionality, pricing, and other qualities of the object. Physical product design, online interface design, and operational efficiencies (Hansopaheluwakan et al., 2020) are a few design fields where this is applicable.

This strategy's key concepts revolve around identifying product attributes and establishing a connection between them and design components. This strategy is built around three key concepts: thoroughly understanding the Kansei customer; reflecting on and implementing Kansei knowledge into a product design; and creating new framework and structure for the Kansei-oriented design. (Hihara, 2009).

A. Ergonomic Survey Study Chair with Anthropometric Approach and Quality Function Deployment

Every client wants to feel comfortable, thus any designer who focuses on maintaining a high standard for customers has a serious challenge. Customers are often willing to pay more for an item if it genuinely meets their needs if the price is higher. It is anticipated that this design will act as a blueprint for pleasant, portable, and widely available folding study seats (Luthfini Lubis and Vivi Putri, 2020). The process of developing client wishes is derived from the previous stage's House of Quality (HOQ) matrix; via this process, it will be known how the customer requires for a product, therefore it's something that is a useful input for

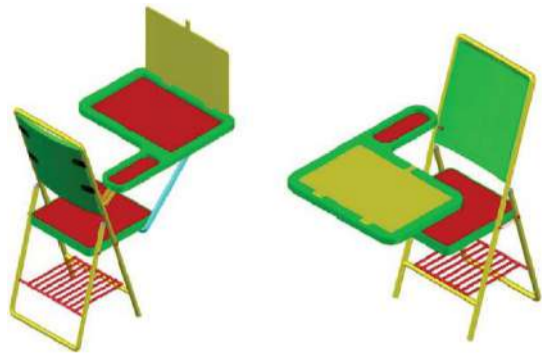concept development (Felekoglu and Ozmehmet Tasan, 2020).

Figure 3. An anthropometrically-based ergonomic study chair with quality function deployment (QFD)

Ergonomics is a structured field of research that combines information about human nature, propensities, and restrictions to design practical systems that enable people to live and work in ways that are efficient, secure, and enjoyable while also achieving the desired goals. In general, ergonomic studies have two primary goals:

1) To improve people's dependability, performance, and efficiency of work by enhance the effectiveness of interaction between people and other work atmosphere components while lowering the level of human mistakes; and

2) To improve people's dependability, performance, and efficiency of work by enhance the effectiveness of interaction between people and other work atmosphere components while lowering the level of human mistakes; and Concept selection is the technique of assessing concepts by paying attention to client requirements and other considerations, comparing the relative strengths and weaknesses of the concept, and selecting one or more concepts for further inquiry, experimentation, and execution (Bonilla et al., 2008).

Figure 4. Ergonomic study chair with table for all ages

In order to create this product, the anthropometric measurements of the child's body are first obtained, and the percentile values for each dimension are then computed. Later, a guide called The House of Quality was created to help consumers identify product attributes. The researcher

constructs the physical three-dimensional form of the product after all the data is ready.

Seven crucial factors, including product functioning, safety, life cycle, material, aesthetics, ergonomics (comfort), and economics, are proved to have an impact on consumers' propensity to purchase products. Planning for the level of consumer interest in and satisfaction with product design is therefore made easier.

A. Design of Geriatric Reading Chair Using Quality Function Deployment (QFD) Approach to Minimize Musculoskeletal Disorders

The reading chairs that are presently on the market will be contrasted with the geriatric chair that was constructed using the QFD approach. The picture depicts a competitive reading chair design that is already available and is frequently used by people to read at home and unwind (Figure 5). The HOQ matrix comparisons reveal that the reading chair design that will be manufactured outperforms

Figure 5. Existing chairs on market using quality approach

competitors' reading chairs in a number of aspects, including feature innovation that is better suited for user demands, comfort level, and reading chair design that will be modified to increase comfort.

The results of the design of reading chairs for the elderly are shown in Figures 4 and 5, with dimensions based on the results of anthropometric measurements and modified with the researcher's consent. The design of the rejuvenation reading chair includes the aspects that are described below.
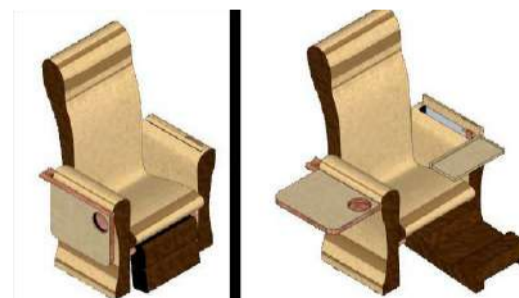

Figure 6. The design of the reading chair for the elderly

i. Rear of the chair:

The back of the reading chair for seniors is designed to fit their anthropometry while they are sitting upright and straight. This is done to make sure that older persons reading

4

recommended to sit upright with your back straight. Leaning forward might result in neck and back pain, which can make it challenging to concentrate. Additionally, make sure the spine is positioned upright. Sit upright in a chair and press your cartilage firmly on the chair's back to reach this position. Because it hurts, avoid leaning over.

ii. Footstep:

Reading chairs include steps because it is recommended to maintain the legs straight when reading a book, with the thighs parallel to the floor and the lower legs perpendicular to it (Mukhtar, 2019). Footprints on the frame of the chair support the elderly's feet when seated in a reading chair. The angle of the footstep may be adjusted to suit the user's preferences and comfort.

iii. Have a drinking establishment:

In order to make it simpler for seniors to store their drinks while reading books, the reading chair has a compartment for food and drinks that is connected to the chair. Everyone needs to drink water, but it's especially important for the elderly since they are more likely to get dehydrated (Yōji Akao, Mazur and King, 1990).

4. Results

A.   *Result of Survey*

8 Kansei phrases were identified that reflected client voices based on a preliminary poll that was conducted. It was put to the test using the 5-percent fault tolerance listed in table below.

Table 1. Kansei words – Breakdown

Selected Kansei Words	Description
Comfortable	Provide a cozy layout.
Innovative design	Provides comfort when using distinct chair designs.
Durable	The most recent chair model is long-lasting.
Adjustable	Users can choose a low-height seat to make themselves comfortable.
Affordable prices	The price that the client can afford.
Interesting colors	The user may indulge their enthusiasm thanks to the chair's appealing hue.
Safe	Chairs constructed of a sturdy and secure material
Easy to move	The layout of the most recent design makes it simple to move about.

B. Result of Mapping Process for Design

Table 2. Comfortable Mapping Concept

Kansei Word	Concept	Design Specification

Comfortable	Comfortable cushion	
	Not storing heat	Material: Foam
	Not smelly	Material: Polyester
	Appropriate shape	Interior of a square with a curve
	Comfortable backrest	
	Backrest position	Position – $90^\circ – 100^\circ$
	Backrest shape	Full back cover
	Comfortable writing table	
	Table shape	Rectangle
	Armrests exist	Material: Poly Urethane
	Armrest shape	Rectangle
	Material for table	Material: Wood

Table 3. Kansei Word of Comfortable Design in Part

Design Specification	Design explanation
	Chair Cushion
	Backrest
	A cozy writing surface
	Arm- rest

Table 4. Innovative Mapping Concept

Kansei Word	Concept	Design Specification

Innovative	Innovative design	Backrest to table: 27 cm
	Storage rack exist	
	Drink bottle rack exist	
	Backpack holders exist	Fishing hook shape

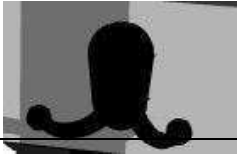Table 5. Kansei Word of Comfortable Design in Part

Design Specification	Design explanation
	Entry and exit capabilities
	Storage rack
	Bottle rack
	Backpack holder

Table 6. Durability Mapping Concept

Kansei Word	Concept	Design Specification
Durability	Padding for the backrest and cushions is of high quality.	Material: Foam
	Backrest and cushion pads layers made from quality material	Material: Coldore
	Made from high-quality material are the backrest and cushion's exterior.	Material: Polyester

Table 7. Adjustable Mapping Concept

Kansei Word	Concept	Design Specification
Adjustable	Table easy to fold	then fold sideways
	Height in relation to body size	Popliteal height dimension
	Type setting	Folded up

Table 8. Affordable Mapping Concept

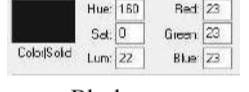| Kansei Word	Concept	Design Specification
Affordable price	Chair with affordable price	Rs. 5,000.00

Table 9. Attractive Color Mapping Concept
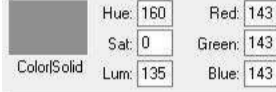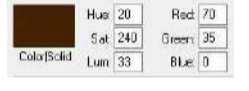
Kansei Word	Concept	Design Specification
Attractive colors	Chair with appealing colors	Gray
		Blue
		Brown
		Black

Table 10 Secure Mapping Concept

Kansei Word	Sub Concept	Design Specification
Secure	Secure Frame shape	There is a hole in the center of the circle.
	Strong Materials used	Iron

Table 11. Easy to move Mapping Concept

Kansei Word	Concept	Design Specification
Easy to move	The chair can move in a lot of area.	Hydraulic mechanical butterfly star legs and thread wheels are used in chairs.

Table 12. Kansei Word of Easy to move Design in Part

Design Specification	Design explanation
	Hydraulic shaft
	Mechanical butterfly

	Star legs and Thread wheels
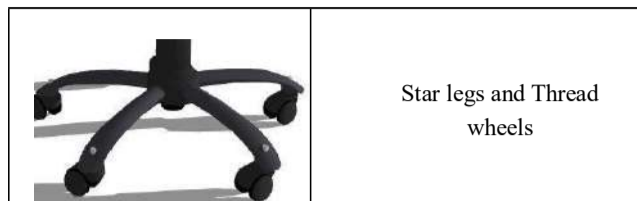
C. Designing the chair virtually

The next stage is to virtually create the reading chair, as the general design is shown in figure below:

Figure 7. Virtual Concept Design
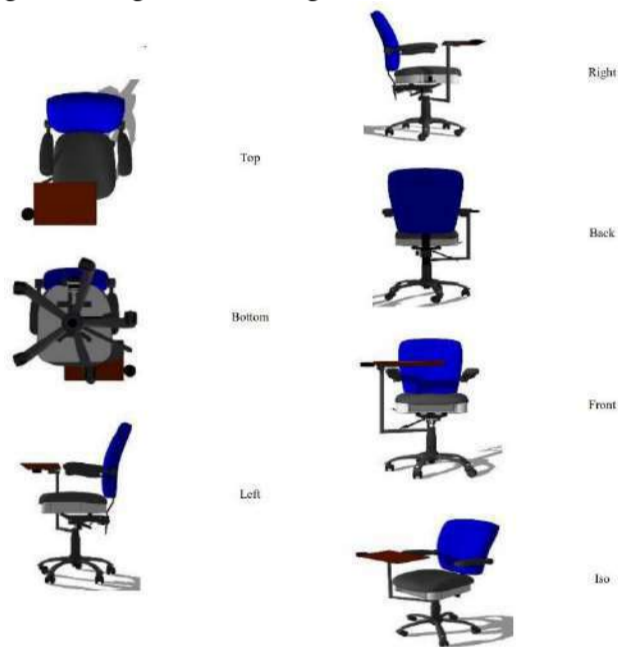
5. Discussion & Conclusion

In the process of product design, Kansei engineering is developed as a visual support technology for making sense of personal imagery and becoming consumer-oriented and in recent years, it has adapted to market development requirements.

The goal of this research was to improve knowledge of the fundamental ideas and procedures of Kansei Engineering. As a result of this study, engineers will be able to consider the emotional characteristics of reading chairs.

As a result of this research, we have found the following results:

1. Among the Kansei words that users require in college, chairs are comfort, innovation, durability, adjustability, affordable prices, attractive colors, and safety.
2. There is a 5% probability that the developed reading chair design will satisfy user requirements.
3. The following are the requirements for comfortable reading seats.
a. With design specifications of 52 cm by 43 cm by 6 cm, the cushions should provide a good level of comfort.
b. For the ability to not store heat, the material is foam, and to avoid odors, polyester is used.
c. Design specifications for a comfortable backrest are 65 cm long, 50 cm wide, and 3.5 cm in height.

- Writing table constructed of wood with a brown finish that is 40 cm length, 25 cm broad, and 2 cm high.
- The armrest measures 25 cm in length, 5 cm in width, and 2 cm in height. The gray armrest is made of polyurethane.
- The backpack holder is 4cm in length and 2cm in width.
- The following are the design parameters for strength: durable cushions are made of foam, and the outer layers are made of polyester.
- The adjustable design requirements are that the table is simple to change position, therefore the design standard is to fold up then fold sideways.
- The design parameter of the frame is a cylinder with a hole in the middle; the material is iron.
- For simple movement, the design parameters are as follows: hydraulic design standards for small shaft diameters of 2 cm and large shaft diameters of 3 cm. The metal is chrome, and the form is a tube.

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Surgical Instrument Tracking and Maintenance System for the University Hospital KDU

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Abstract: Lack of attention to the correct use of surgical instruments leads to errors in practice and especially difficult control losses. The present research aims to effectively use a surgical instrument tracking and maintenance system at University Hospital KDU in Sri Lanka. The features required to develop a system for the institution were identified by studying the existing literature about traceability systems. We decided to use QR code technology to detect and find the location of an individual surgical instrument. While securing the main purpose of the health and safety of patients, the system would increase labor efficiency and lessen worker responsibility, even though statistically significant data have not yet been discovered. The paper also demonstrates the benefits of using a surgical instrument tracking and maintenance system in a hospital's Central Sterile Supply Department. The outcomes of this study will be used for future implementation purposes of the system.

Keywords: QR code, instrument tracking system, medical equipment management system

1. Introduction

University Hospital KDU (Kotelawala Defence University) is located in Werahara, Sri Lanka. The 814-bed hospital is equipped with cutting-edge technology and ultramodern facilities to offer round-the-clock emergency and trauma care as well as specialist treatment of diseases from all medical specialties, including surgery, pediatrics, obstetrics, and gynecology. The hospital contains twenty operating rooms, and the Hybrid Theatre stands out among them due to its new medical treatment approach and the fact that it is the first of its kind in Sri Lanka. Other theaters are likewise specialty theaters built to ISO level 5 specifications. The hospital's Intensive Care Unit is a sizable facility with 70 beds and private rooms for each patient.

Central Sterile Supply Department (CSSD) is the heart of the hospital, it is the place where they decontaminate, inspect, repair, recycle, and sterilize used instruments thereafter providing rapid, efficient, and low-cost maintenance and repacking of used instruments for reuse at the hospital. The records of the sterilization procedure and equipment maintenance must be monitored and controlled by a manual or automated information system at the CSSD.

Tracking is defined as the ability to track and identify surgical equipment and its usage based on previously recorded information. With the increase in surgical case volume, the hospital sees the need of implementing an automated tracking and maintenance system at the CSSD. By combining technology with quality procedures, the automated system would overcome any faulty or misplacement of instruments.

Thereby allowing fast information retrieval and an increase in productivity.

An automated tracking and maintenance system would provide a multitude of functions and benefits, such as reducing human error, tracing instruments (identifying frequency of use, sterilization, repair, storage, product history, etc), identifying patients or procedures, and avoiding scheduling conflicts, identifying instruments that may or may not have been purchased, and having a streamlined workflow.

The CSSD's workflow consists of retrieving, sorting, washing/decontamination, assembling, sterilizing, supplying, and storage. These operations, which involve instruments moving back and forth between various units of the institution and CSSD, are ideal for implementing the system; data capture can offer the following information:

- To which unit the instruments were sent
- By whom the instruments were received and who handed over
- Which instruments are in each set
- Frequency of instrument usage
- Which instruments were broken
- Which instruments were lost

This paper is structured as follows: section two will discuss the existing literature on instrument tracking and maintenance systems; section three describes the methodology and development approaches; its results are given in section four. Discussion remarks are given in section five. Finally, the conclusion is in section six.

2. Literature Review

The review of this literature comes from many sources. This review will primarily focus on the various technologies used to identify medical instruments and the methods used in tracking and maintaining them throughout the sterilization process. The review will provide a good representation of the effective methods utilized by hospitals in handling medical equipment.

All the researchers considered in this literature used some sort of unique identification method for the surgical instruments. (Chu, Lee and Wu, 2012) and (Núñez and Castro, 2011) use QR does identify the instruments uniquely. In Goodali's invention Scanners at each checkpoint will scan the personalized code on each piece of surgical equipment. An alarm is raised if any of the equipment fails to go through the scanning process. (McCay et al., 2009) uses laser-embedded

optically scannable code to identify the instruments. (Fuchs, Hebestreit and Tummler, no date) and (Shipp, 1994) identify each piece of equipment, using a barcode, which consists of alphanumeric characters arranged in a 2-dimensional matrix. The authors' Chu, Nunez, and McCay emphasize the need for adopting mobile portable devices to boost the system's portability and eliminate the need for engineers to leave the repair site to look for information. Further, the authors go on to discuss safety, including how to use personal technologies safely in hospitals and how to handle information safely. The authors, Nunez and Castro also indicate that they use authorization mechanisms such as passwords to grant access to the system to relevant personnel.

There were many other special features found in the research. Goodali's invention entails having an alert system at several checkpoints, such as before surgery, from the nurse to the doctor, after surgery, from the sterilization facility back to surgery, inventory, and then back to the nurse, and so on. Fuch's invention contains several unique features. One is that the system keeps track of how long each piece of equipment is held at a particular transit station. If a station's time is exceeded, it is informed. In addition, the system has saved the production date of each unit so that it can track the unit's age and be notified when it needs to be serviced. The system would also keep track of the weight of the units as they passed through each station, ensuring that they were of the correct composition. Kost and Fry's invention allows searches to be performed based on this last touch criteria to identify instruments that may have been misplaced or need to be cycled. Each instrument's record includes a photograph of it. The technique also helps with comparing instrument counts before and after operation to ensure that all instruments are present. Shipp's invention has a unique characteristic in that it sends acknowledgment when a certain instrument reaches a specific transition. This makes it easier to locate the equipment.

3. Methodology

According to the study of existing literature, the features that need to be in the system were identified. The surgical instruments at UHKDU had already embedded QR codes. Thus, with the available features, the rest of the system was designed. The system will enable the traceability and control of all sterilization process stages using QR code technology.

Figure 1. An instrument having an embedded QR code

The creation of the product and CSSD staff database would require the longest time. Some instruments will be sent as a set and some will be sent as individual instruments. Figure 2 shows how the data will be stored when the instruments are stored as a set (Major basic set for general surgery, minor basic set for general surgery, hernia and appendix set, orthopedic major basic set, etc.). Each instrument will be stored in a container as shown in Figure 3, which could also have a unique QR code.

Name of the item	Amount	Item identification number
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------------	------	--------------
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Figure 2. Instrument Set Database

Figure 3. Instrument Sets stored in containers

The next stage would be to design the system. Figure 4 displays the schematic of the system. Using the information stored on the QR codes, the web application is used to generate services related to tracking and maintenance of surgical equipment.
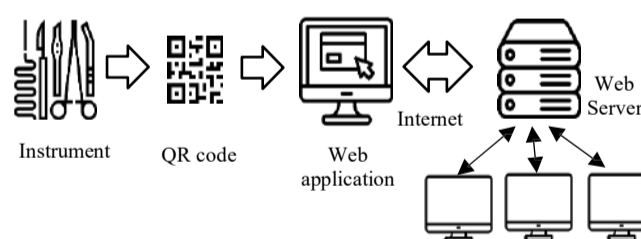
Figure 4. Schematic of the system

4. Results

CSSD is in charge of preparing instrumentation carts for surgeries according to the daily schedule. An authorized nurse at the CSSD can access the system. Some instruments will be sent as sets and some as individual pieces. Each barcode on a container (box carrying a set of instruments) must be scanned separately. Once the case's QR code is scanned, a list of the case's contents is displayed on the

computer screen. The nurse should then scan each instrument individually with a scanner. As a result, the nurse inspects and assembles it. Images and notifications already entered into the database now appear. If the count of instruments in that particular set is correct, the verification button is pressed. After that, a batch number is generated, and the cleaning cycle begins as usual. Then an automatic report is generated with the packing date, the nurse in charge at CSSD for assembly, the number of pieces, and the nurse receiving the package. The system generates a unique case number at this point, which is used to identify the instrument set and track the entire procedure in the administration module. The surgical instruments are then released for the surgical procedure. When the dirty equipment is returned to the CSSD, the case is closed. When a set is returned, again the same procedure is repeated to check the count of the individual pieces. Similarly, an automatic report is generated with the return date, the nurse in charge at CSSD for receiving dirty instruments, the number of pieces, and the nurse who handed over the package. The system implementation is explained in Figure 5.

5. Discussion

Nowadays, the benefits of using automatic identification technologies, such as QR codes, for improving patient safety have been established. However, the success of these technology projects depends on the understanding of thorough planning for the management of requirements, risks, and obstacles to implementation.

The present study demonstrates that, despite the fact that unique identifying codes are embedded into some surgical instruments, the technology has not been utilized at UHKDU. It is a major concern because there is no planning for restructuring and prioritizing these procedures. The majority of hospital employees oppose changes in workflow, which leads to a lack of awareness of new technologies.

A key difficulty in justifying and using technology in the institution is employee training. People can be trained to increase their awareness, acceptance, and proper use of technology, both in terms of benefits and utilization. As a result, training end-users can aid in the adoption of process modifications and lead to higher efficiency in the new processes. Users who have been properly trained can also help to eliminate errors.

Another critical consideration is the type of instrument identification. Various optically scannable identification methods (such as barcodes, QR codes, and so on) were discovered to be utilized in the existing literature. The identifying type must be carefully chosen. In our research, however, we preferred using QR codes because most equipment at UHKDU already had the code affixed.

6. Conclusion

We found that the most significant challenges to the successful implementation of the QR code system were a lack of expertise and understanding of the infrastructure, as well as insufficient staff training and funding for training.

Recommendations:

Managers and hospital directors should prioritize employing this technology more effectively by explaining the benefit of using QR codes and the return on investment or costs of this technology to them.

It is advised that all medical staff who work with QR codes be ready for its consumption. Employee training is necessary to ensure performance at a level that is acceptable and appropriate. Additionally, it is safer if the QR code system is thoroughly tested in a much smaller space, such as a single clinical department, before being introduced into all hospital processes.
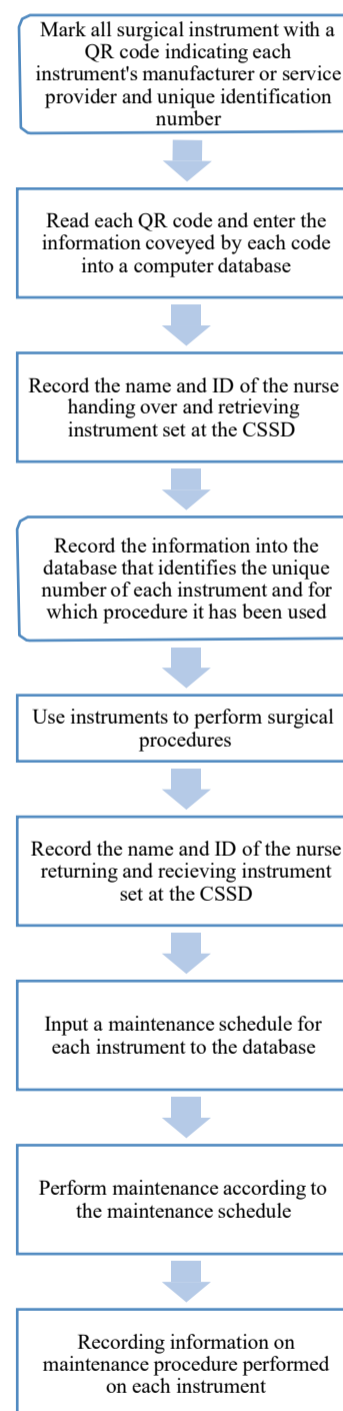

Figure 5. System implementation

7. Future Work

The benefits of having an automated tracking and maintenance system for the hospital's CSSD are presented in the study. It is a progressive and complete procedure that requires time and adjustment even after it has been implemented. The involvement of the CSSD nursing staff will be critical throughout future implementation. Based on the findings and design of this study, future work will entail the development of an efficient and effective web-based surgical instrument tracking and maintenance system. In the future, anyone with an interest in this topic can use the tools and procedures indicated as appropriate by this study.

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Development of Heated Jacket for bike riders using Kansei Engineering

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Abstract*: Due to metabolic heat generation of our body, we are very uncomfortable in both cold and hot weather, especially when we work hard. In cold weather we wear jackets & trousers to have more comfort. Thus, we have developed an innovative evaporative type of motor bike seat, jacket and a trouser that have been designed and fabricated using multiple heating coils. Measurements are taken from multiple feedback thermal sensors which are widely spread in the seat, jacket and the trouser. Then those readings are sent to the Control Unit and after that, the heating coils adjust the temperature to match the demand of the body temperature. We have designed the bike seat to transmit the electricity power to the trouser using wireless power transmission. This trouser has a small power cord that connects to jacket for the purpose of distributing power to the top of the jacket.*

Keywords*: Heated Jacket, Kansei Engineering, Bike Riders*

1. Introduction

Motorbike jacket is very essential for bike riders as it offers protection for the riders in case of an accident or a crash. Also, it covers the rider from adverse weather conditions, dust and sun. There are various kind of motorbike jackets available in the market, designed using different materials such as leather motorbike jacket, the wax cotton motorbike jacket, laminated waterproof jacket, mesh motorbike jacket, etc. Other than the most common factors such as appearance, cost, weight, etc., the most important design aspect of a jacket is to provide safety and comfort for the rider. It is said that the most important factor which will ensure a safety ride on a bike is feeling comfortable and relaxed. But during cold and rainy conditions riders may feel uncomfortable and it might affect their safety and health. Therefore, if it is soaking wet and freezing cold It is very important that a biker stays dry and warm. Saying that, it's very important for rider to choose a right jacket by the rider. In this research we have developed a heated motorbike jacket that will be useful for motorbike riders to enhance their comfort during cold weather conditions, using Kansei Engineering (KE).

Kansei Engineering is also known as emotional engineering or affective engineering. It is the process of translating emotions and needs into a product design by using customers' psychological feelings.The Kansei engineering method involves a series of steps. The first step of the statistical process is to collect suitable Kansei words.The second part of the study involves a Kansei evaluation experiment in which participants rate the designs using Kansei words with a Semantic Difference (SD) scale.Finally, a statistical procedure will be used to analyze how words relate to the product design elements. Several fields are involved in the implementation of Kansei Engineering, including methods from psychology, marketing, and statistics. KE studies are based on quantitative and qualitative research steps.

A. Existing Systems

There exist several heat jackets developed during the past years but most of them are having issues while using the product. Following are some famous products.

1) Torch 2.0 Coat Heater

This Torch Coat Warmer is a small, battery-powered heater that fits inside any jacket. Three thin heat pads offer heat for up to four hours on a single charge, and three heat settings allow precise customization of the temperature. The Torch 2.0 Universal Coat Heater & Warmer is a set of three thin heat pads that can be strategically put inside a coat or jacket, one in the back and two in front, one on each side. When pulled the coat heater and warmer out of the package, there is only one button, the power button, and it is also used to cycle among the three various heat settings, which are accessed by repeatedly pressing the power button. The button is located on the same panel as the secret battery pocket, so once connected, all you have to do is reach into your jacket and touch the conveniently accessible button to switch the device on or off and alter the heat level (Gin, no date).

2) Universal Coat Heater

The universal Coat Heater is a portable, battery-powered warming product that is intended to fit in any jacket. Therefore, the coat can be machine washable and the user can stays warm in anywhere they go. Universal Coat Heater can be quickly removed from your garment and transferred to other coats using Velcro, allowing you to heat any

clothing you possess. (Action Heat Adult 5V Universal Coat Heater | DICK'S Sporting Goods, no date). Therefore, to combat the winter conditions, the user can convert any garment into a battery-powered heated jacket.

3) Alexa-connected heated jacket

Like a future electric blanket, this jacket contains carbon fiber wires running up its back and sleeves to heat it for all weather wear. There were heated Olympic jackets, as well as linked jackets with touch-sensitive fabric, such as Google's and Levi's Commuter jackets. This is unique in that it is an automated heat-regulating jacket. It's just a heated jacket with a thermostat inside that can connect to Alexa via an Alexa skill that runs on echo. The jacket is heated by a normal 10,000 mAh replaceable battery.

The coat is powered for around four hours via a USB connector in the pocket. Internal and exterior temperature sensors, as well as an accelerometer, are incorporated. The motion and temperature sensors in the jacket will automatically regulate the heating based on your surroundings. Three heating options are available via an Android and iOS phone app (low, medium, high), Using machine learning, the app will learn your preferences over time. The Alexa-enabled function just turns the jacket on and off, so in principle you could say "turn my jacket on" as you leave the house and never worry about it again.

Main drawbacks identified in existing heat jackets are that they can only be adjusted to a fixed inner temperature which doesn't depend on existing body temperature and that the existing jackets are having only a limited duration of battery life which doesn't last long.

2. Methodology

Heated Jacket was chosen as the product domain. The participants were the people who ride motorbikes. Kansei words were collected from different sources such as research papers, magazines and literature reviews. Words that had a higher grade were selected. Namely comfortable, flexible, modern, durable, smart, and safe. Through the analysis the likes and dislikes of the people to a this kind of product were identified. The product of this research is a heated jacket that works through DC electricity by using 7 heating coil packs of 3W power with wireless technology. The questionnaire conducted in this research consists of questions about the experience of bike riders in Sri Lanka. The general idea about the heated motorcycle jacket was gathered through the the questionnaire and then the gathered data was analysed in order to design the product. Qualitative responses were quantified through a 1 to 5 likely scale. After describing the meaning of Kansei words, participants were given a brief introduction about how to complete the survey. Fig 1 represents the procedure of this study.

The 20 terms that have been compiled into a new database for the heated jacket are listed in Table 1 below. It was necessary to gather some words (Kansei words) that could represent consumer wants and relate to the product in order
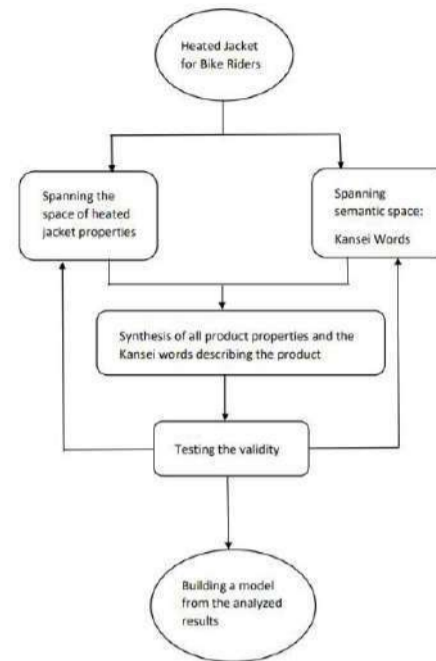

Figure 1. Conceptual Diagram of Heated Jacket using Kansei Engineering

to come up with suggestions for a new product that would suit the client's needs. The Fig 1 represent the procedure of this study.

Table 1. Kansei Words

Modern	Expensive	Comfortable	Durable	Stylish
Sporty	Smart	Unique	Attractive	Flexible
Safety	Simple	Youthful	Elegant	Suitable
Charming	Dressy	Good shape	Trendy	Artistic

3. Results

We have gathered data using the survey, focusing following basic ideas.

1. The general idea about the heated motorcycle jacket

2. How it affects Sri Lankan community

3. Preference of the community to new technology

4. Benefits of the product

5. Drawbacks of the product

From this survey our aim is not only implementing this jacket but also to introduce this new technology to Sri Lanka and give this marvelous experience to the Sri Lankan. So, we have asked several questions to get to know the community ideas. During the survey, we got responses from

351

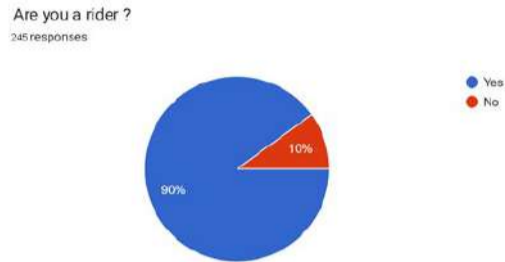245 persons and following charts shows the results of the survey.

Figure 2. If responder is a rider

In the questionnaire, first we asked the age and gender of the respondents to get an idea about our respondent sample. We were able to gather data from all the ages and genders in order to have clear idea about their opinions. But most of our respondents belong to 18-25 age limit and 68% of our respondents are males and following graphs shows the results.
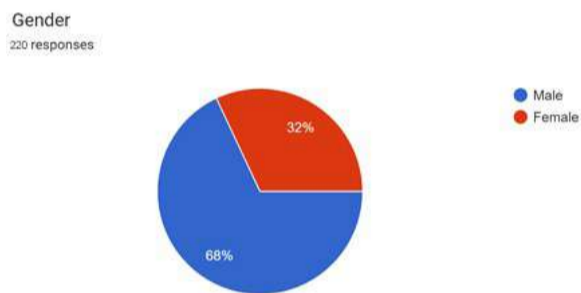

Figure 3. Responders' gander

Also we found out that 55.6% of the responders are riding under cold circumstances and a 18.5% of responders, relatively low number, are riding under warm circumstances. These numbers means most of the people can get benefit from our heated jacket.
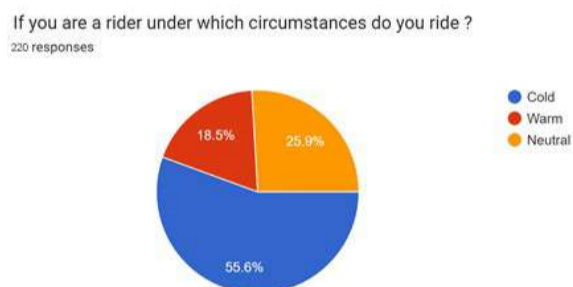

Figure 4. Riding circumstances

According to the next output of the survey, we found out that 32% of the people are used to ride average of 1hour – 2hour per day. Which means we have to consider about the continuous power supply for 1 – 2 hours. A relatively low number, 20% of responders have less than 30min of average riding time per day.
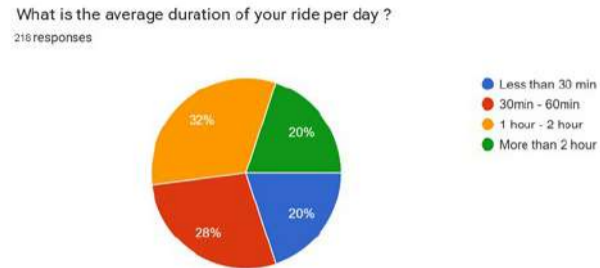
Figure 5. Duration of the ride

Then we found out that the frequency of rides of the responders. 32% of responders ride few times a day which implement that this category benefits mostly from our product. Only 4% of people is riding less than once or twice a week.
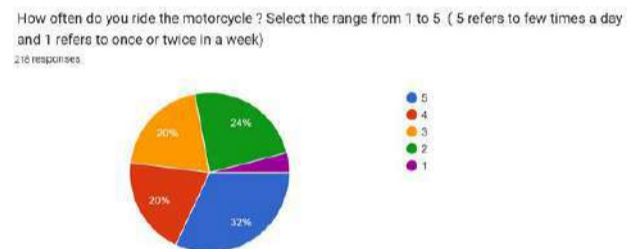
Figure 6. Riding frequency

Next part of the survey revelas that, 60% from the respondents are already using a motorcycle jacket. We can clearly say that since they already used to use a jacket, there will be no issues with them in using a jacket. The other 40% is a drawback and we can focus the reasons of not using a jacket as a further step.
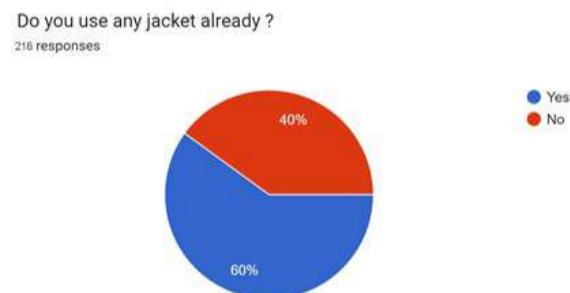
Figure 7. Usage of a jacket

Another problem we identified is backwardness in adapting to new trends. Only 16% of people says that they do not want to try this new technology. 84% of people think they should try out this technology. This is a good situation and below pie chart shows those responses.
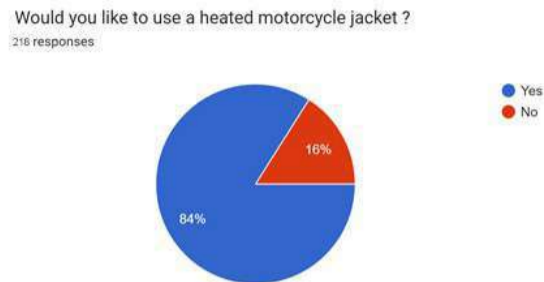
Figure 8. Likely to use a jacket

in the questionnaire we asked some questions regarding the technology they prefer to use for charging and for changing the temperature. 84% of responders prefer to use an automatic temperature changing function for the heated motorcycle jacket. Only 16% of responders think that changing the temperature manually, would be most suitable.
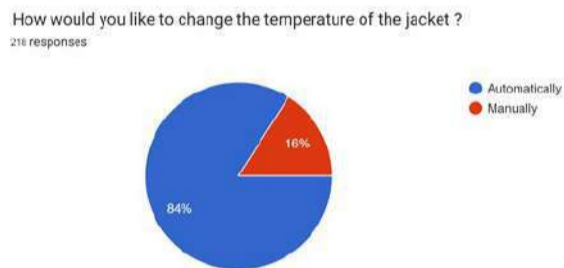
Figure 9. Requirement to change temperature

Another point is whether the people who would like to use our heated jacket will like to use a wireless charging method. 80% of people think it's a good idea to use a wireless technology for this heated jacket.
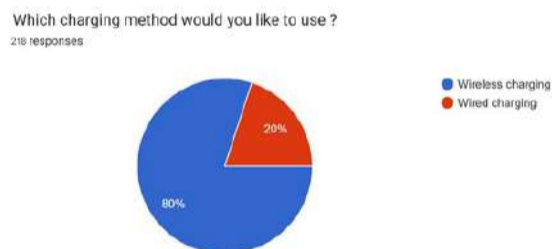
Figure 10. Charging method preferred

A. Final Design

Influenced by the responses of the survey we have designed the final product as follows. In this design we have modified the motorbike seat and the jacket. The design was divided mainly in to two parts.

1. Motor Bike

Seat 2.Motor Bike

Jacket

The heating system of the bike jacket is working through DC electricity by using 3W and 7 coil heating pack. Also this jacket is working using wireless technology. While the rider rides the motor bike, there's a wireless power transmit method between the jacket and motor bike seat to transmit electricity power to the jacket.

1. Motor Bike Seat

This seat already has a power transmit coil pack. Assume it is a 50w electricity transmit coil pack. In the image below the motor bike seat design explain how the power transmit coil pack is included.
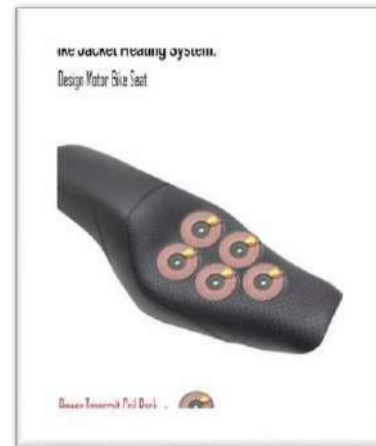
Figure 11. Motor Bike Seat

According to this plan, we have designed the motor bike seat to transmit electricity power without a wired connection to the motorbike jacket.

2. Jacket

Jacket has being designed with two parts.

• Trouser.

• Top of jacket.

Trouser

The trouser includes an electricity power receive coil pack and the power is transmitted to the top of jacket through a wired connection. When the motor bike rider sits on the motor bike seat, this connection automatically transmits electricity power to the trouser's coil pack.

Figure 12. Trouser - Front

Figure 13. Trouser - Rear

Figure 14. Jacket - Front

Figure 15. Jacket - Rear

In back side of the trouser there is flexible power receive coil pack. The trouser have a small power cord that connects to the top of the jacket in which, the purpose is to distribute power to the top of the jacket.

Top of Jacket.

The top of the jacket includes following

- Heating coil package (Each package 5W)
- Temperature sensor
- Controlling Unit
- Reachable Li-ion battery pack (7.4 v)

The heating coil package warms the inside of the jacket. The body temperature is measured at every instance by multiple temperature sensors and the average value and sent to the controlling unit. The heating coil package is controlled according to this feedback of the control unit. When rider is riding the motor bike, sometimes for few seconds wireless power transmit may get disconnected or get weak.The Li-ion battery pack is used to avoid this issue. As a result of using the Li-ion battery pack, the control unit has continuous

electricity power to maintain the process without any disturbance. This battery pack is also charged from the power received by the trouser. In the back side of the jacket, there is a power code that connects to the trouser in the top of the jacket.

4. Discussion

B. Limitations

Wireless charging pads are costlier more than wired chargers. As a pretty new technology, it's more costly to purchase a wireless charging pad, especially when new smartphones come with a wired charger in the box. Charging receptors need to stay on the pad in order to continue charging and takes considerable time to charge. The efficiency of wireless charging is still lower than wired charging, thus it takes more time to charge wirelessly using the same amount of power. Wireless charging supposedly takes 30-80% longer time to fully charge your device than a cable.

C. Further works

Reduction of the power loss due to wireless charging is a major concern to be improved in our next stages. As a result of the ongoing Economic Crisis many people have attracted to use bicycles for their transportation requirements. The target user crowd of the 'Heated Motorcycle Jacket' can be extended to bicycles riders as well.

5. Conclusion

Based on Literature review and methodologies applied herewith its observable that proposed 'Heated Motorcycle Jacket has an admirable advantage to the motor bike riders. Specifically for the riders in cold and soft weather condition changing areas, where the daily precipitation is a cross between mist and drizzle and sometimes referred as "mizzle". The rain does not fall to the ground in heavy droplets but seems to hover and linger in the air which can be very disturbing to the rider. Along with the usage of wireless charging, we have obtained the advantages of having less cords to worry about with wireless technology. User don't need to carry around a USB-c charger. It is just needed of one cable that is connected to the charging mat. Universal compatibility - Qi charging is the universal standard for multiple different wireless capable devices and can be used the same charging pad without any issues.

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E-Agri Web Application for Agricultural Development in Sri Lanka

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Abstract:*Sri Lanka has been an agricultural country since the age of kings. As one of the main economic streams in the country,, it brings a massive amount of foreign exchange to strengthen the economy. Rice and organic food consumption have drastically increased due to the population and high demand for fresh and healthy foods. Both fruits and vegetables are cultivated all across the country. Including the highlands of the central province and the in-land areas. The main reason to build an E-commerce platform like this is to address the problem of unnecessary involvement of the middlemen who buy produce from farmers and sell it to customers. They are the ones who control the market price and cause unnecessary price hikes, gaining the highest profit from the business. Because every farmer doesn't have the storage and transport facilities to deliver the product to markets. Farmers can't get the price they deserve and the customers have to pay extra. The solution suggested in this research paper will stifle this problem by keeping a steady market price while farmers can make a better profit from their products. Therefore, they can widespread their sales all over the world. Through this e-commerce platform, farmers can suppress the middlemen's involvement by directly interacting with customers. Nevertheless, with this web application, users will be aware of the agricultural products in the nearest locations. This web application can reduce the wastage of food in transport. Anyone can buy the products they need with great comfort.*

Keywords : *e-commerce, agricultural goods, web application.*

1. Introduction

Currently, most of the farmers in rural areas are going through difficulties in introducing the products to the consumers. For example, when a client requests sure agricultural merchandise from a third party, the 0.33 celebration will then have to contact the cultivators to get the anticipated products, subsequently having a third party consumes greater time than the purchaser contacting the cultivator directly.

This agricultural e-commerce software with the usage of the internet is developed as an answer to the above-mentioned problem. Once the photo is uploaded, the utility has the functionality of figuring out the contents of the picture to understand which product category it belongs to. Shipping the agricultural merchandise will then be in the methods after it is agreed both to pay by using Pay Online or Cash on delivery.

2. Related Work

Impact on Market & Retailers

This research focuses on a variety of e-commerce websites. To be precise, this research uses the C2C e-commerce approach for agriculture, to be achieved via existing methodologies in e-commerce. Also, this web application aims at both non-computer literates and computer literates in the field of agriculture. The demands of e-commerce for buying and selling via the Internet are expanding every day with the sophisticated needs of educational, business, and even sociological landscapes.

The existing e-commerce web applications in the world do not provide the functionalities for any non-computer literate users. Almost all e-commerce sites have complicated interfaces and therefore novice users come across a greater probability of being resistant to using such systems.

It is in this light, that the demand has risen for a simple, user-friendly, c2c e-commerce web application to be developed which would have the ability to make it possible to be used by non-computer literates to sell and order via the internet, which will be a great incentive as an outcome morally as well as monitory for the cultivators. Also, consumers can buy fresh products much faster without third-party involvement

- *Computer Literacy and Language Literacy of the people in Sri Lanka*

For e-commerce, computer literacy data can provide immeasurably an understanding of the demand and supply of skills in the global, knowledge-based economy.

According to the Sri Lanka Department of Census and Statistics ―Computer Literacy Statistics – 2017 (First Six Months), the results for computer literacy in different age groups, sectors and provinces, language literacy areas as well as occupational groups are given in the tables as shown above.

A person between the ages of 5 and 69 is considered computer literate if he/she can use a computer on his/her own. For example, if a 5-year-old child can play a computer game, he/she can be considered computer literate.

The average rate for computer literacy in the first half of 2017 for Sri Lanka was reported to be 28.3%. The above survey results show an increase of 0.8 percentage points from the first half of 2016 to the first half of 2017. The urban sector shows the highest computer literacy rate of 41.1% among the residential sectors, while the rate for the rural and estate sectors shows computer literacy at 26.5% and 9.5% respectively.

The complete Computer Literacy reported in the first half
of 2017 for Sri Lanka is 28.3%. The above survey results demonstrate an increase of 0.8 percentage points from the first half of 2016 to the first half of 2017

The above-presented table reveals that computer literacy is higher among those who are also literate in the English language.

According to the survey it has displayed that English literates have a percentage of 72.5 computer literacy than Sinhala and Tamil literates who has computer literacy at 33.5% and 26.5% respectively. The table presented above has discovered that Skilled Agricultural workers as well have the least knowledge in the field of computer literacy, in Sri Lanka.

Image Processing Methodologies in the Industry

In mobile, web and software development images serve for many reasons, including Object recognition, Pattern recognition, identifying duplicates (exact or partial), Image search by fragments, Camera image processing, and Improving mobile apps UX, Augmented reality. Generally, image processing consists of several stages: importing image, analysis, manipulation and image output. There are two methods of image processing: digital and analogue. This article is all about digital image processing and its methodologies. Which means altering digital images with graphical software tools.

As it has just been established, various factors can adversely affect RTR image quality. With the use of image enhancement techniques, the difference in sensitivity between film and RTR can be decreased. Several image processing methods, in addition to enhancement methods, can be applied to improve the usefulness of Data. Methodologies include convolution edge detection, mathematics, filters, trend removal, and image analysis.

D. *Technology adoption and why does it matter?*
Various technologies can be used to implement most of the software and hardware development projects. Some projects are way better implemented with specific technology combinations (Azati, 2017). Technology selection is therefore very critical and plays a key role in software development research.

Especially, concerned about the following factors when making decisions about technologies for the development of the software like fruitfulness, Fault tolerance, Flexibility and reusability, Time and cost efficiency, User-friendliness, Attractiveness of the interfaces, Future maintenance, and Overall performance

3. Materials & Methods
This research deploys a combination of quantitative and qualitative methodologies for gathering and analyzing data. Quantitative methods, the positivist paradigm, emphasize numbers and frequencies rather than meanings and experiences. These methods provide information which is easy to analyze statistically and tend to be more reliable for making visions. In this project, quantitative analysis was done to evaluate metrics such as the time elapsed for new users to join how much data is needed to input to the system to retrieve an output and the time duration taken by the system to recognize an uploaded image. The data collected via the pilot testing done in this regard will be analyzed in the post-research review.

Qualitative methods, the phenomenological paradigm, are ways of collecting data which are concerned with describing meaning, rather than

withdrawing statistical inferences. It provides more in-depth and rich descriptions. Observations and discussions with potential users are the methods that were used in the project to find the issues when registering into the system, the complexity of using the web application, the difficulty in understanding the user interfaces, the language with which the interfaces are displayed in, how the products are being filtered according to the search details which are provided to the system by the user, the ability of the device to successfully access the website and acquiring the output of a certain task. The technology

that will be used in the system will be as Framework: Laravel version 5.5 LTS, Architecture: Model-View-Controller (MVC) architecture, Language: PHP, CSS, JavaScript, HTML, JavaScript, Python, AJAX, Database: MySQL, Software: JetBrains PHP Storm, XAMPP, OpenCV 3.0.1, Method of data analysis: Machine Learning, Method used for Machine Learning: Oriented FAST and rotated BRIEF, Machine Learning framework: Numpy, Payment Gateway: PayHere: PayPal, Working Internet Connection.

Use of Chosen Technologies

Laravel Framework

Laravel is an open-source PHP framework, which is robust and easy to understand. It follows a model-view-controller design pattern. Laravel reuses the existing components of different frameworks which helps in creating a web application. The web application thus designed is more structured and pragmatic.

Model-View-Controller Architecture

The MVC paradigm is a way of breaking an application, or even just a piece of an application's interface, into three parts: the model, the view, and the controller. Model-View-Controller is a really good way to develop clean, scalable, powerful and fast applications in the least amount of time and with the least effort.

MVC architecture with PHP

It's a software architecture built on the idea that the logic of an application should be separated from its presentation. A system developed on the MVC architecture should allow a front-end developer and a back-end developer to work on the same system without interfering with each other.

Model.

Model is the name given to the component that will communicate with the database to manipulate the data. It acts as a bridge between the View component and the Controller component in the overall architecture. It doesn't matter to the Model component what happens to

the data when it is passed to the View or Controller components.

View

The View requests data from the Model component to determine the final output. View interacts with the user, and then transfers the user's reaction to the Controller component to respond accordingly. An example of this is a link generated by the View component when a user clicks and can get triggered in the Controller.

Controller.

The Controller's job is to handle data that the user inputs or submits through the forms, and then the Model updates this accordingly in the database. The Controller is nothing without the user's interactions, which happen through the View component.

PHP

Hypertext Preprocessor is a server-side scripting language designed for web development but also used as a general-purpose programming language.

There are three main areas where PHP scripts are used;

Server-side scripting: The user needs to run the web server, with a connected PHP installation and can access the PHP program output with a web browser, viewing the PHP page through the server. Writing desktop applications: Some advanced PHP features could be used in client-side applications to write such programs. The user also can write cross-platform applications this way.

Python

Python is a high-level, interpreted, interactive and object-oriented scripting language.

Python is interpreted at execution as it does not require the program to be compiled before execution.

Python is interactive and allows the interpreter directly to write any program.

Python is Object-Oriented and encapsulates code within objects.

AJAX

AJAX stands for Asynchronous JavaScript and XML. AJAX is a new technique for creating better, faster, and more interactive web applications with the help of XML, HTML, CSS, and JavaScript.Ajax uses XHTML for content, CSS for presentation, along with Document Object Model and JavaScript for dynamic content display.

Conventional web applications transmit information to and from the server using synchronous requests. With AJAX, when you hit submit, JavaScript will make a request to the server, interpret the results, and update the current screen. In the purest sense, the user would never know that anything was even transmitted to the server.

MySQL

MySQL is an open-source relational database management system (RDBMS). MySQL uses Structured Query Language (SQL). SQL is the most popular language for adding, accessing and managing content in a database. It is most noted for its quick processing, proven reliability, ease and flexibility of use. MySQL is a mandatory part of almost every open-source PHP application.

JetBrains PhpStorm is a commercial, cross-platform IDE for PHP built on JetBrains' IntelliJ IDEA platform. PhpStorm provides an editor for PHP, HTML and JavaScript with on-the-fly code analysis, error prevention and automated refactorings for PHP and JavaScript code. It includes a full-fledged SQL editor with editable query results.

JetBrains PHP Storm

JetBrains PhpStorm is a commercial, cross-platform IDE for PHP built on JetBrains' IntelliJ IDEA platform. PhpStorm provides an editor for PHP, HTML and JavaScript with on-the-fly code analysis, error prevention and automated refactorings for PHP and JavaScript code. It includes a full-fledged SQL editor with editable query results.

OpenCV.

OpenCV is a cross-platform library using which we can develop real-time computer vision applications. It mainly focuses on image processing, video capture and analysis including features like face detection and object detection.

Computer Vision Vs Image Processing

Image processing deals with image-to-image transformation. Both input and output of image processing are images. Computer vision is the construction of specific, meaningful descriptions of physical objects from their image. The output of computer vision is a description or an interpretation of structures in 3D.

Machine Learning with python

Python has libraries that enable developers to optimize various algorithms and use them. It implements popular machine learning methodologies such as recommendation, classification, and clustering. Therefore, it is necessary to have a brief introduction to machine learning before we move further. To achieve the successful conclusion of development with a fully functioning outcome, a proper design is a must, as the design sets the foundation for the project and would determine if the project will achieve its final goals. Not having the design in place would mean that the scholar would have to face many unexpected and unsolved challenges during the execution of the research. This is both cumbersome and time-consuming. and will result in the scholar not being able to complete the project in time. Hence all design aspects of the project should be thought of in

detail before the implementation can begin. The following illustrates a diagram of the overall architecture of the system application. To build the e-commerce website, the architectural structure uses an MVC architecture consisting of N layers, such as the model, view, controller and user. The figure also illustrates which layers will normally be categorized by the 3-tier architecture consisting of the layers which are known as the presentation layer, business layer and data layer. The purpose of the MVC pattern is to separate the model from the view so that changes to the view can be implemented, or even additional views created, without having to refactor the model.
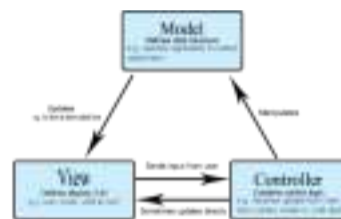
The following image illustrates the complete working process of the system. Every single user will initially have to register with the system to proceed with any further actions. Once the user logs into the system, the user will be directed to their specific user profile. The user may insert/retrieve/update/delete data accordingly as per the provided privileges. The main modules in this web application are; Image recognizing, Insert/retrieve/update/delete, Shopping cart, Payments handling, Dashboard handling, and Stock Handling

To develop an efficient and effective e-commerce web application, certain tasks must be performed to manage all the processes of this application.

- Ability to provide secure authentication.
- Ability to enter data by users.
- Ability to store and maintain a database.
- Ability to manage website content.
  - Fast and accurate search function filtering by customer's location.
  - Prioritize the content displayed on the item page based on user preferences.
- Ability to offer sale promotions and discounts
- Use of report generation mechanisms.
- "Help" facility is always available for users.

- Email marketing integration.
- Inclusion of an in-app wish list for users to bookmark items they wish to purchase in the future.

4. Discussion

websites based on e-commerce act a crucial role in the modern technology field. It is possible to overcome geographical boundaries as the products will be accessed by anyone from being at any place. Hence, the limitation to a single geographical area is solved by giving access to the products to customers island-wide, the customer base for all suppliers can be gone on an upward trend. Consumers can locate the ideal product as per their needs efficiently without any hassle. The consumers will be provided with a range of product variations based on their search criteria. The products can be filtered according to where the producer is located and the results from the nearest location will be displayed. The excess delivery expenses will therefore be reduced for the supplier and the customer may receive the requested products in no time. Abundant information is provided through this website for the product consumers. Awareness of products unique to specific locations can be raised through this website. This is a website made with simple interfaces and stepwise proceedings for non-literate users to either buy or sell their products with the least knowledge. Because image processing is used to identify the product images uploaded, the system, therefore, acquires lesser details to be inserted by the user to post their product to sell. The website provides the admin with statistical data on a pie chart regarding the purchases done through the site per year and per month as well as the system provides statistical data for every user with each of their monthly purchases and sales did pe r the current month.

This is a web application specially built focusing on non-English literates and non-computer literates which enables all users to do any process stepwise regardless of their rate of literacy.

- Easy to use checkout.

- Various payment handling methods such as; Delivery and Pay Here.
- Websites should be mobile-friendly.

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A Systematic Application to Manage Residential Rental and Maintenance in Sri Lanka

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Abstract: The impact of the COVID-19 outbreak was felt across all real estate management. A slowdown in the house rental and maintenance management system can be anticipated, as a result of the lock-down and limitations in financing with the most severe impact is on the inability of handling the relationship between the house owners, tenants, and the handyman. Property management is a crucial component of being a landlord, but it is far from straightforward. An appropriate methodology was carried out by the researchers to identify all the problems regarding real state property management through quantitative and qualitative data gathering procedures such as semi-structured interviews, face-to-face interviews, questionnaires, and direct observation of the selected sample. After analysing, the house owner must screen tenants, collect rental fees, handle complaints, and keep tenants satisfied, among other things. In this pandemic situation, tenants faced more difficulties such as difficulty in finding a better house, paying monthly payments, paying utility bills, loss of connection with house owners, and finding the nearest handymen. Handymen suffered a lot mainly because of the inability to find works. Researchers' main aim is to give an appropriate solution for Sri Lankans to manage house rental and maintenance. By examining the responses this investigation shows that a mobile application would be a better solution than implementing a web application. Iterative waterfall methodology was used for implementing this application. The researchers decided to develop this application using android studio. To enhance the effectiveness of the system by using 360 VR photography, Machine learning (ML)-based technologies, OTP/Fingerprint for User Verification and Geolocation, and Geo-tagging.

Keywords: House Rental Maintenance Management, 360 VR Photography, Machine Learning

1. Introduction

Serious implications have happened with the Sri Lankan economy with the global crisis. The real state sector is the main sector affected due to this pandemic situation. Due to changes in the rental market, landlords reported lower rental income and lower spending to compensate for the increased risk of losing renters. There are some issues for renters to find the most suitable house. Handymen are people who suffer more by non-job during these days, and most of they haven't money to fulfill their daily tasks.

Therefore, the main aim of the research was, find out the challenges faced by the tenants, handymen, and house owners in current real estate management and give them a solution by implementing an android application for house rental and maintenance management in Sri Lanka. Their main objectives of the research were,

[1] Analysing the challenges faced by users in current house rental and maintenance management.

[2] Examine the current and existing developments which have been done regarding house rental and maintenance management in both Sri Lankan and worldwide contexts.

[3] Analysing the opinion on implementing mobile applications and designing an architecture for implementing a mobile application.

It is especially important to keep an efficient communication between the landlord, tenant, and the handyman, hence the use of mobile phone applications for contact tracing during the COVID-19 pandemic, the researchers have identified that implementing a mobile application is more efficient than developing a web application.

To appropriately determine the processes and house rental and maintenance system users' requirements, quantitative and qualitative methodologies are applied. House owners, tenants, and handymen are the primary sources of collecting data by conducting semi-structured interviews, face-to-face interviews, questionnaires, and direct observation of the selected sample. Secondary data were collected through a survey conducted by house owners and tenants. Factors found to be influencing the real state of Sri Lanka have been explored using websites and literature papers of current and past decades. Technologies that were used were 360-degree VR photography that keeps human interaction in which users interact with and manipulate a simulated real or imaginary environment. Geo-Location & Geo Tagging, during pandemic situations helpful to find a nearby handyman using a variety of location-specific information and to identify the geographic location of the handyman, specifically near the specific house that needs repair and maintenance service. OTP/Fingerprint for User Verification-It is advantageous when it comes when paying rental payments, utility bills, handyman payments requests because fingerprint identification is unique, highly accurate, and simple to use. Identifying all the problems and difficulties faced by Sri Lankans, the researchers proposed an appropriate housing rental and maintenance management application.

2. Literature Review

COVID-19 has been a once-in-a-lifetime challenge for the global society and markets. Even if the situation in Sri Lanka is less serious because it can be handled with a lower number of infected people and deaths, the impact of COVID-19 on the country's broader socio-economic setting is difficult to assess. Because it has such a large impact on all market operations, real estate actors are particularly interested in the ramifications. "Whether it is a challenge or an opportunity" is a controversial theme to go forward in the market under the constricted circumstances created by COVID-19's abnormal unpredictability. However, it is possible to argue that recognizing possibilities from challenges and transforming obstacles into opportunities is the most strategic course of action in the country's real estate sector at this critical juncture.

Several studies investigations have been carried out on the obstacles and opportunities that the COVID-19 pandemic has presented to the real estate sector. The coronavirus damaged the whole market, including the global real estate industry. This is the challenge's immediate and short-term character or COVID-19's direct impact. The challenge's indirect and long-term nature can be observed if we approach it without identifying the hidden chances and taking advantage of them.

Ruzaik, F., & Begum, M. (2021) carried out research to identify the socio-economic issues that this COVID-19 pandemic has created, with a greater emphasis on human well-being. The majority of the data was derived from secondary sources. The results revealed that low-income earners, daily wage laborers, and the business community are the socioeconomically most affected persons as a result of the curfew and lockdown situation. A considerable amount of literature has been published on property management systems all around the world and in Sri Lanka in past few years. Those discussions implicate the findings to future research into this area.

In the past two decades, several numbers of researchers have sought to determine rent house management systems with basic technologies (Gommans, P *etal, 2014*) Factors discovered to be impacting the housing sector be diligent in facing the challenges of change by implementing a new strategy that allows for easy rental property administration. Existing systems having basic features such as using the command buttons to manipulate the database, having the ability to add deleting viewing, and inserting data. The role of object-oriented programming and the role of relational database management system managing mostly important task. The systems having very simple interfaces only with the details of the tenant and the property owner.

Omosebi, P. A., & Adeoye. (2016) conducted research that resulted in the creation of a web-based housing management system. The system's purpose is to manage senior staff housing and to make it easier to apply for and update housing. It also enables the housing unit to gain simple access to data, boost productivity, and reduce manufacturing costs. The approaches utilized in this study were Adobe Creative Suite 5, which was used to construct the front end, while CorelDraw Version 15 was used to design the visuals on the pages, and XAMMP Server version 5.3.5, which had PHP and MySQL applications, was used to make the site pages dynamic. Housing management systems are intended to handle data, keep track of it, and enable quick access to accommodation applications. This is necessary to establish decision-making procedures and institutional arrangements. However, suggestions for further enhancement were given, such as including a mobile alert and payment system notification. Problems of the existing system were typically characterized by paper-based information management practices; the existing system does not give room for application to be filled at convenience. Examines the flow chart, Logical view of the new system, Alternatives to the existing system, The advantages which have been identified by maintaining a web-based application were Easy deployment, Security, highly economical, Cross-platform compatibility, and easy access to the database.

These studies discussed the study of implementation of Android Applications for housing society management. Throughout the android platform, this project mainly used "Push notification Technology". In this research Gavhane, S., *et al* (2015) discussed the disadvantages of the existing system such as unreachable information, Lack of authenticity and reliability, Time consuming activity and missing of acknowledgment. This paper proposing a smarter way of communication, fruitful solutions for Day-to-day notifications for meetings, Parking, miscellaneous contacts, security alerts. Application-based on the mobile platform it uses MVC architecture.

In 2019 Shriram, R., & Nandhakumar, P. researchers establish a web application helps the user to register individual home or apartment to assist you to find the perfect rental home or property for search view in your target area. Understanding how exhausting it is to contact individual property agents, schedule appointments, and find a better time for appointments, and supply better service. This website is designed to fulfill all needs from buying property, selling property, leasing the property. The Apartment House for Rent in Metropolitan Cities is what the Home Rental System is searching for.

This app (Nandhini, R et al, 2018) focuses on building a better relationship between buyers and sellers by simplifying many tasks such as mainly focusing on the nearest location prediction, identifying the vacant places, sending automatic rent reminders, package notifications, utility bill, emergency info, location information. In extend system added the GPS in build and giving a live chat online option. Java script technology was used for implementation. The suggested approach supposes security mechanisms using a distance-vector algorithm including the message exchange and updates message security authentication mechanism without introducing significant network overheads and complexity.

A considerable amount of literature has been published on mobile applications for real estate management in various countries. These studies Chohan, A. H. *et al* (2017)

presented a model mobile application to the automated monitoring system to determining the quality of housing to check the performance of low and medium costing and its assessment, study briefed about the transformation of empirical housing data into the integrated software to determine housing quality. This study identifies the design quality indicators and parameters for affordable housing in Karachi Pakistan, the context of quality indicators for housing design, and classified under various segments of housing design components. The need for mobile application for the housing sector was categorized as for proposing a conceptual model for the building envelope design process, proposed a model for selection of interior finishes and floor covering materials, developing an automated building element selection system.

Questions have been raised about the safety of prolonged use of appropriate things online. Kasamani, B. S., & Gikundi, D. (2017). proposing a recommendation system that allows the users to hold out a preference-based cooperative filtering search on rental properties which preferences based on shallow learning, which could be applied to ease the task of locating the desired things online. AR and Vuforia are also used to visualize the space. The system was designed as an internet application victimization handlebar for the front-end and Nodes-ExpressJs for Back-end. The system performs better than existing algorithms and predicts better in a memory-based approach. The system performs better than existing algorithms and predicts better in a memory-based approach. Recent evidence (Kim, H., *et al*, 2020) suggests the solutions for proving adequate public rental housing (PRH) with decent quality and desirable location. This study utilized a machine learning technique called long short-term memory (LTSM) to construct a set of housing price prediction models which indicate the proximity to impact on nearby housing prices at the city and the neighbourhood level of public rental housing. The approach taken by the study can facilitate improving the PRH policies and programs.

The first serious discussions and analyses of technologies that were used to improve the efficiency of real estate management applications were emerged during the 2019 s by Ullah, F., Sepasgozar, S., & Ali, T. H. (2019). Disruptive digital technologies are a necessary part of today's reality. These technologies are converting traditional industries into more innovative and adaptable ones around the world. The situation of global real estate, on the other hand, has failed to improve and is currently falling behind the technological curve. As a result of this latency, the relevant information is either not made available to end-users or is shared too late, resulting in increased risk. Users of internet real estate platforms have expressed their concerns. As a result, there are more vacancies and post-occupancy regrets among the service providers.

The Big9 technologies, which include drones, the internet of things (IoT), clouds, software as a service (SaaS), big data, 3D scanning, wearable technologies, virtual and augmented realities (VR & AR), and artificial intelligence and robotics, are assessed and addressed as the new technologies which using for real estate management.

The RESTAM framework, which focuses on online platform-based real estate users, is expected to lay the groundwork for introducing the missing technology acceptance model for real estate stakeholders, so the real estate business is transforming traditional to smart real estate because of Big9 disruptive technologies. This will lessen real estate service users' post-occupancy regrets and improve relationships amongst diverse real estate stakeholders.

Walmsley, A. P., & Kersten, T. P. (2020) found new methods for creating information-rich interactive 3D environments are becoming increasingly in demand as virtual reality (VR) and the corresponding 3D documentation and modeling technologies evolve into increasingly powerful and proven tools for numerous applications in architecture, monument preservation, conservation/restoration, and the presentation of cultural heritage. The researcher discusses the creation of an immersive virtual reality application for the Imperial Cathedral in Königslutter, in which 360° panoramic pictures were merged as a novel and complementary method of visualization within the virtual world. So those empirical studies which were published open a path for a researcher to establish this implementation.

3. Methodology

Towards an explicit research methodology adapting on the research onion model for this study is much efficient for the researchers, Research philosophy of this research is based on finding the best-suited android application for house rental maintenance management of Sri Lanka. As ongoing research, it adheres to the view that only factual knowledge is gained through the observations and measurements, the researcher conducts a positivism research philosophy. A deductive approach was conducted by the researchers through this research, investigated through examining the existing application on real estate management of Sri Lanka which was invented and used by the expertise.

As the researcher mentioned previously, the first objective of this research is to identify and analyse the challenges faced by users in current house rental and maintenance management. And the third objective of the research was to analyse the opinion on implementing mobile applications and designing an architecture for implementing the mobile application.

To discover both mentioned objectives researcher identified a specific set of people for the data collection. The specified audience were Sri Lankan tenants, handymen, and house owners. Researchers supposed that the best way of collecting data from a specified audience was through a mobile survey.

Then researcher conducted a mobile survey among a specific group of people. And researcher used to have some observations of the current situation and took some ideas from users by meeting them directly through video

conferencing. The firsthand attitudes of the community were collected by using primary sources mainly from semi-structured interviews, face-to-face interviews, questionnaires, and direct observation of the selected sample. Personal records, client histories, and service records give additional information on existing systems.

The second objective of the research was to examine the current and existing developments which have been done regarding house rental and maintenance management in both Sri Lankan and worldwide contexts. Then researchers review research papers and websites. The analysis of those papers was mentioned in the above literature review.

The researchers used several kinds of research strategies such as conducting surveys on the identified audience, understanding the grounded theories and algorithms which were used, clearly understanding the current scenario, and focusing on the best solution for recovering the problems in the current situation. Researchers use an interactive inquiry technique that combines collaborative problem-solving with data-driven collaborative analysis or research to uncover underlying causes and make predictions about personal and organizational transformation in the future. The strategy of ethnography of acknowledging the background, habits, lifestyle, behaviour, mutual differences, and the different perceptiveness of the clients. Time horizon takes a major part in research for a while, here a cross-sectional time frame was used to conduct this research at one point in time using different samples of a selected group of people and the snapshots of a given point in time change at a societal level. Requirements for the mobile-based feedback system are collected during the literature review by observing similar types of systems and fact-finding techniques. This system is technically feasible as most of the house owners, tenants, and handymen have a smartphone.

The system is developed using android studio, Android SDK, and NetBeans. The server-side language is Java and database based on cloud technology. The Google Play store sells Android apps, and researchers use the Google Pay API to integrate them. The developer even set it up to accept credit cards. To integrate the app and set it up to accept credit cards. The researcher will define the google pay API version to request a payment token for the payment provider. Then developer should define the supported payment card networks and describe all allowed payment methods. Moreover, create the PaymentClient instance by determining the readiness to pay with the Google Pay API. Then developer should create a PaymentDataRequest object for registering event handler for user gesture to handle the response object. Iterative waterfall methodology is used during the development of the system as it reduces the developer's effort and time required to detect and correct the errors. To protect the health and safety of individuals conducting surveys [15] and prevent disease transmission, the Coronavirus Disease 2019 (COVID-19) has changed how survey data is now collected. During all stages of the pandemic, data on human behaviour is needed to make effective and timely decisions. Mobile phone surveys (MPS) can provide real-time information on behaviour, exposure, knowledge, and perceptions, as well as advertising and marketing, and resource allocation. MPS have become popular in low- and middle-income nations due to increasing mobile phone penetration. MPS can be conducted without interacting with responders in person, making them particularly useful in the event of a pandemic. Rapid MPS, which requires no human resources, may reach many people in a short amount of time and is a useful tool for assessing knowledge and perceptions of an infectious illness during an outbreak as well as tracking trends over time.

A. Sample Population

The population of this research to gather data through questionnaire was selected normally from the people older than 20 years. People have been classified into three categories as house owners, tenants, and handymen. Thus, a non-random sampling method was used to select the sample among them covering several provinces in Sri Lanka. Among the identified population, about 134 sample population was selected to elaborate and collect the data while some data was collected through the research papers done regarding this field. To that, to maintain high data accuracy, a formal way has been used in collecting data.

B. Data Gathering

The survey data for this study was gathered through a questionnaire and literature reviews. The survey was conducted by delivering a questionnaire to publications and websites. This was done to collect 70 Customers or tenants, 26 house owners, and 38 handymen and the literature review was completed by consulting 15 research data extremely precisely to improve the effectiveness of the research outcomes.

4. Results & Discussion

Although the first objective of the research is to identify the challenges faced by the tenants, house owners, and handymen. As a result, the data was gathered by the quantitative approach using a survey. Those results were analysed by the researcher as mentioned below.
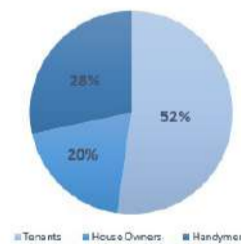
Roles

Figure 1. Designation Population Distribution

Analysis and Interpretation: As shown in Figure 1 of the 130 specimens that responded to the survey plurality of 52% were Tenants, 20% were house owners and 28% were handymen.

A. Confirmation Statements

Confirmation 1		No	Maybe	Total
	Yes			
Facing a lot of challenges for daily life and economy due to covid -19 pandemic	119	2	13	134

Table 1. Confirmation Statement 1

Analysis and Interpretation: Table 1 shows the responses of the sample population for confirmation statement 1 and most of the respondents have agreed with the statement by giving all together 132 responses for yes and maybe.

Confirmation 2	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total
Opinion on implementing mobile application to overcome the problems in house rental and management system.	91	27	9	4	1	134

Table 2. Confirmation Statement 2

Analysis and Interpretation: Table 2 shows the responses of the sample population for the confirmation statement 2. Most of the respondents have agreed with the statement by giving all together 118 responses for agreeing and strongly agree with implementing a mobile application to overcome the problems in the house rental management system.

B. Challenges for house owners for their economy due to the covid-19 pandemic.
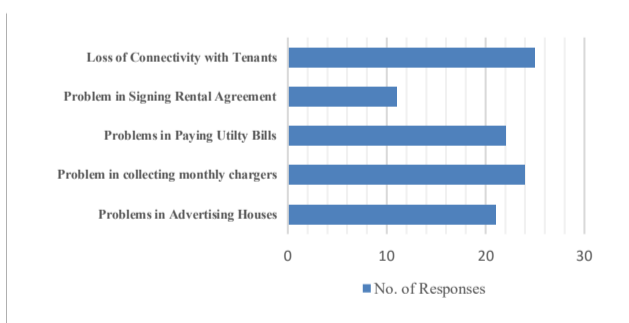
Figure 4. Challenges faced by House Owners

Analysis and Interpretation: Figure 2 shows the Challenges for house owners for their economy due to the covid-19 pandemic. Other than these challenges owners mentioned that it was very difficult to identify the nearest handymen for services.

C. Challenges faced by tenants due to the covid-19 pandemic
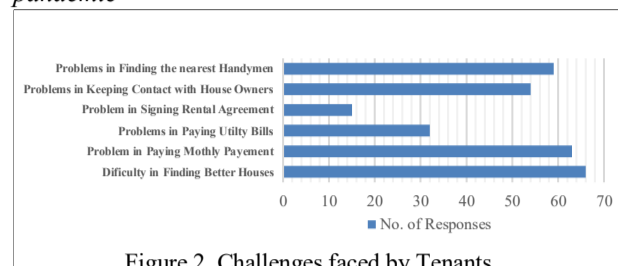
Figure 2. Challenges faced by Tenants

Analysis and Interpretation: Figure 4 shows the samples listed the attitudes on problems faced by tenants.

5. REQUIREMENT ANALYSIS
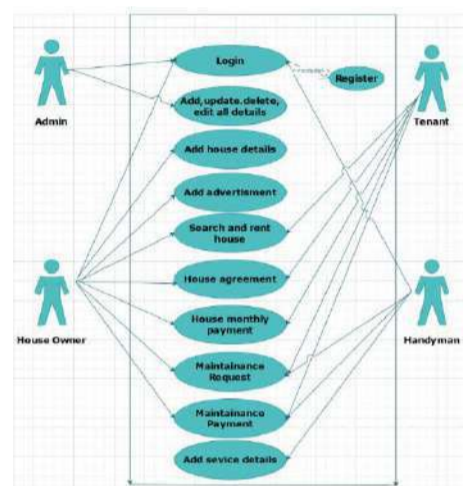
Figure 3. UML Use Case Diagram for Proposed System

There are four main user types in this system. This proposed system may be accessed by the administrator, house owner, handyman, and tenant using those four unique logins. Furthermore, each house owner and handyman have a unique username and password provided by the system when they register. The tenant can log in with their username and password, which they created when they first registered to the system. The major functional requirements are listed below.

Admin should be able to,
- Perform CRUD operations in the system.
- View house owners, houses, tenants, and handyman's details.
- Remove property advertisements.
- Update and remove owner-related house details and handyman details.

House owner should be able to,
- Add advertisements including house details.
- View appointments of tenants
- Search rented houses and tenants' details.
- View tenants' requests for maintenance.
- Sign house rental agreement with the tenant.
- Do handymen payments if need.
- Change own profile details and password.

Tenants should be able to,

- View the properties available.
- Choose suitable houses and create an appointment to meet the owner.
- Choose the nearby handyman who suits their task.
- View the details & contact the handyman.
- Pay handyman payment.
- Sign house rental agreement with the owner.
- Pay house rental fees and utility bills through the app.
- Change their profile details and password.

The handyman should be able to,

- Notifications about the requests.
- Change their profile details and password.
- Add/Update their qualifications.
- Take work from the tenants and house owners.

5. System Design

A. Technologies

This mobile application supports the following technologies. The interactive viewing of panoramic images, usually comprising a 360-degree circle or a spherical perspective, is known as VR photography (virtual-reality photography). The art of recording or generating a full scene as a single image, as seen when rotating around a single central spot, is known as virtual reality photography. The entire virtual reality image might be a computer-generated effect, or a mixture of photography and computer-generated objects, and is usually formed by stitching together a series of photographs taken in a multi-row 360-degree rotation or utilizing an omnidirectional camera. To give the best experience for tenants can optimize 360 player experiences for mobile applications, The application supports all panoramic images. Images can be captured with a 360 camera such as Ricoh Theta, Gopro MAX, Insta 360, or DSLR. Images can be rendered using 3D software. House owners could be uploaded and shared on the application. The efficiency of the application is increased as VR photography keeps human interaction in which users interact with and manipulate a simulated real or imaginary environment.

The sole purpose of the smartphone app is to make our lives easier. As a result, when developing an Android application to provide the best handyman service, it's critical to consider the consumers' ease in locating the handymen closest to them. As a result, the most significant feature in this application is the 'Find Nearby Handyman' option. Along with the location selection, it assists users in the following ways.

Machine learning (ML)-based technologies are rapidly being employed in real estate property management to improve service quality and efficiency. In-house rental and maintenance management presents a novel strategy for precisely predicting which handymen are located. The researcher employs global positioning system (GPS) information from tenants' and house owners' mobile devices as well as Wi-Fi data that covers the whole area. researchers learn some of the user's behavioural preferences based on the prediction findings. Researchers use these projected handyman locations to give more accurate services to our tenants and house owners.

All these novel technologies that the researchers are supposed to use will enhance the system's performance. Panoramic images which were added using 360 VR photography, will help users to take an accurate imagination of the houses. And machine learning, GPS, Geo location and Geo tagging technology, which use to increase the easiness of finding nearby handymen. The authentication level of the application increased by OTP/Fingerprint.

6. Design Approach

The house rental and maintenance management system mainly consist of seven main modules. Interactive mobile prototypes were created for each module for efficient the tasks of implementation.

A. Registration and Login Module

House owners, handymen, and tenants should register for this system by themselves by entering their username and password as they preferred. Those usernames and passwords are used to log in to the system. If required users can change their passwords after login into their account. Login function should be used to access system users to log into the system. Users should already be with their usernames and passwords.

B. Administration Module

The administrator has the authority to access all the house owners' details, property details, handyman details, and tenant details. Admin can access the system by adding, editing, and deleting, and removing the users.

C. House Rental Procedure Module

Figure 5. Mobile Prototypes for Login and Registration Module

The system provides the main function as rent a house. Property owners can advertise an advertisement to rent their houses. The owner should enter the house details which are mainly useful for tenants. owner details should be supplied for the contact purpose. House ID is auto generated when posting a house. Tenants can go through those advertisements to choose the best house by contacting using house owner details.

Mainly house owners can capture images of houses using a 360 camera and 3D software can be used for rendering the images. And those photographs can be posted with house details to give the experience of the house.

Figure 6. Mobile Prototypes for Rental House Procedure Module

D. Handymen Service Module
The main function given by the application is handyman can add their service details to the system on their own. Tenants can go through the relevant service category tenant can find the handyman who can fulfill their request and contact through handyman details. Nearest handyman, prediction is most efficient during the current situation. The handyman who is available for the chosen service category were shown on the map with their location.

Figure 7. Mobile Prototypes for Handymen Service Module

E. Rental Agreement Module
Renting a house according to the rules, regulations, and policies is the main thing to avoid conflicts. after tenants choose the best suitable house for them an agreement should be signed between the house owner and the tenant. By using this application that purpose can be fulfilled. the owner and tenant can upload and download those relevant documents and those will be fully secured.

F. Payment Module
There should be a connection between the tenant and the house owner mainly for the payment purpose. Payment services that were supplied by this application are tenants having the ability to pay monthly house rental for owners with utility bill payments and handyman service payments If not only the monthly rental payments for owners, but other bills can also be paid directly through the application.

Owner and tenants can pay an advanced payment or full payment when requesting a service from the handyman. Tenants can transfer money to the handymen's bank account and the house owner's bank account through this application.

G. Notification Module
Reminders, Notifications, Emails, and Messages are compulsory in connecting the users of the application. The system should generate notifications on requests for maintenance service, tenants should be notified with newly posted advertisements, rental house payments, utility bills, and handymen payments. House owners should be notified of rental payment, tenants, and handyman requests. The handyman should get reminders on their scheduled works, tenants' requests are accepted or ignored.
After designing the flow of the application, researchers will implement this application according to conclude the analysis of the results. The application should be tested by involving a sample population and encouraging users to provide their opinion with feedback and suggestions for this application.
Finally, researchers conclude that establishing this application by targeting the real state users of Sri Lanka will effectively increase the direct communication and engagement with clients, improve customer engagement, create loyalty among users, get ahead from the competition between the companies, offers unique services, and create useful marketing in real estate industry in Sri Lanka.

7.   Conclusion and Furtherwork

This paper presents a solution for problems faced by Sri Lankan house owners, tenants, and handymen during this covid-19 pandemic situation. As the mobile phone is an essential device for people in these days mobile application takes a prominent place so for further works researchers would recommend improving this android application with many more categories for users and to improve above-mentioned limitations and it would be more helpful for face the challenges in real estate industry in Sri Lanka during this covid-19 pandemic situation.
For future works, researchers plan to develop the paramedic application activating a mobile application into the IOS platform. Further, this system can be improved by using this application in both Sinhala and Tamil languages and USSD activation mode can be developed in this system as additional functionality.

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Private Motorcoach Management System

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Abstract: *Management Systems are very popular in the present day. The goal of this research is to determine how to make the transition from a manual, paper-based Private Motorcoach Management System to an automated one by enhancing and perfecting the current automated Private Motorcoach Management System. This will make it easier to employ automated Private Motorcoach Management Systems more effectively and eliminate the usage of manual paper-based systems. The purpose of this research is to examine the effectiveness of currently used Private Motorcoach Management Systems, how they utilize new technologies, and what areas will need future attention. The conclusion of what features should be produced in the current automated Private Motorcoach Management System for future enhancement can be reached with the use of published research studies, questionnaires, and interviews. This paper looks into the ways of improving the existing Automated Private Motorcoach Management System in order to help with the transition from a traditional paper-based Private Motorcoach Management System to an automated Private Motorcoach Management System.*

Keywords: *Technological Systems, Management Systems, Motorcoach Management Systems*

1. Introduction

This chapter will briefly describe the Private Motorcoach Management System (PMMS). This is one of the proposed solutions that can be used any private motorcoach companies, especially in Sri Lanka. The main aspects to be discussed include the background to the system, the problem statement, the project objectives, and the scope of the project.

Bus transportation services in Sri Lanka are operated by both the government and the private sector. Most of the population in developing countries depends on public transport. The private bus sector in Sri Lanka consists of 19,000 vehicles, which are independently owned, mostly by single-vehicle Owners. Currently the owners follow manual procedures to manage their business procedures. Which means all their records about income and expenses employees and their salary payments, maintenance details and expenses from minor repairs to major repairs, loan/finance payments and profit calculating are doing manually. Within this manner owners are not able to manage their income, expenses, and get a proper idea about their upcoming maintenance and loan/finance payments, also the employees are not able to get to know how their salaries are calculated.

Aim

The main aim of this research is to introduce a novel and fully automated system to handle the private motor coach system. As the existing motor coach system is manual and paper based, the proposed system will help to reduce the prevailing issues and newly introduced features will enhance the performance also.

Objectives

- Daily profit calculation
- Cost calculation depending on the route
- Salary calculation and view ability to the employees
- Predict and notify upcoming maintenance
- Record employee details and their salary payments
- Predict and notify upcoming loans/finance payments
- Reduce occurring unexpected expenses.

Only a small percentage of private motorcoach owners in Sri Lanka are integrating with automated private motorcoach management systems; the majority of owners still use paper based PMMS. The majority of automated Private Motorcoach Management Systems lack an active system that is current, and those that do have an active system encounter issues interacting with it.

2. Literature Review

2.1 Key Definition

a. Transportation

Transportation is typically a means to other ends, in both its passenger and freight aspects. (Pisarski, 1981) Transportation refers to the different ways that people and/or products are moved from one location to another. The ability and willingness to move huge numbers of people or big amounts of freight quickly and safely across long distances has grown, and this is a sign of civilization in general and of technological advancement in particular. Simply, A means of moving from one place to another is transportation. Air, land (train and road), water, cable, pipeline, and space are all forms of transportation. Infrastructure, transportation, and operations make up the field. Trade between people is necessary for the growth of civilizations and is made possible by transportation.

b. Private Motor coach System

A motorcoach is a large vehicle used for public transportation. When examine the research articles we can see, there are little number of scholars talk about motorcoach systems. It is less than the number of fingers of

the hand. It is very timely to talk about such a topic in such a situation.

2.2. Management System for Private Motor coach

c. Modern Technology for Transportation

Efficiency, convenience, and safety are the three requirements that essentially give rise to innovations in transportation technology. Working together, scientists and experts in the transportation sector make sure that these new technologies move more people (or objects) faster, safer, and with the least number of resources. The combination of accumulated technology plus planned resource allocation has not altered the fact, however, that the cost of adequate mobility is very high. (Owen, May 1962) Further he said Current transportation developments imply that completely new methods and approaches could significantly improve an efficient mobility strategy. The biggest omission in foreign assistance programs may be the lack of research and development to investigate these possibilities. If any country has the technical capacity to develop a transportation system that can move people and goods anywhere, anytime with a maximum of efficiency and comfort at reasonable cost, that was the benefit of modern technology.

d. Inventing Information Systems

As it relates to how information and communication technologies (ICT) can be used to enhance business operations and modernize the value chain systems that organizations use to procure, produce, and deliver goods and services around the world, the study of business information systems may cross disciplinary boundaries.

2.3 Different system for Cost calculation, Salary calculation, Maintenance & Financing

a. Salary Management Systems

Salary administration is listed as a technique. In general, it is a mechanism that informed management uses to assess the value of a contributor's contribution. This management decision-making process will eventually consider the potential of the individual as well as performance. (FLEET, NOVEMBER 1967) Employee salary management system is a web application, enabling the organization to handle salaries of employees. (Muhammad Azeem, 2011-05-12) As well Another scholar explained why we need this type of system, In the past, it was had to manually complete the wage entry, computation, and total number processes. Low processing speed and easy error-making lead to low efficiency when the volume of data is fairly huge. (Zhang Hao, 2012)

b. Maintenance Management System

For the computerized management system called as a CMMS. Software that centralizes maintenance data and facilitates maintenance operations is known as a computerized maintenance management system, or CMMS. It assists in maximizing the use and accessibility of tangible assets like machines, transportation, communications, plant infrastructures, and other assets. (What is a CMMS? n.d.) In order to transport goods efficiently, it is critical that vehicles operate at a high level

of availability or uptime and, in particular, avoid failures that result in unforeseen stops by the side of the road. Failing to complete the transport mission and an unforeseen stop by the road can result in costs such as delivery delays as well as damaged cargo. (Lindgren, 2017) Maintaining regular maintenance is one crucial element for managing uptime. However, due to the costs associated with planned downtime and workshop activities, excessive maintenance is not ideal. As a result, to establish the best possible balance between maintenance and failure risks, maintenance should be scheduled.

c. Financing System

We need system for calculating expenses, identify incomes, get proper idea about loans. Then we can get proper idea about financial stability of a any organization. There are lots of system created for with different purposes. Business owners often arrange for this to be customized.

3. Methodology

The objective of this research which aims to examine how to update traditional manual paper-based Private Motorcoach Management Systems and the use of automated Private Motorcoach Management System as well as identify the potential problems while integrating with the prevailing automated Management Systems. The describing study was conducted to identify the problems in this filed. The area of study was Private Transportation Sector in Sri Lanka. Private motorcoach owners, passengers, employees were respondents of the research.

A. Collection of Sample

The population of this research was private motorcoach owners, passengers, employees in Sri Lanka. Since there was a large population of private motorcoach owners, passengers, employees nonrandom sampling method was used. To increase the data accuracy the sample data was taken from Western province, Central province, Southern province and Northern province.

B. Collection of Data

In this research, as an instrument for data collection questionnaire and interview and published research studies on private motorcoach management systems have been used. Questionnaire distributed online through google forms as well as hardcopies for those who don't have access for google forms. Several interviews were conducted to improve the quality of this research.

Through this research, several specific facts were determined. Such as still most of the private motorcoach owners going with manual paper- based systems and the problems regarding that, problems related to the automated private motorcoach Management Systems while integrating with it such as the updating of the systems, user friendly issues, Motorcoach owners

cannot directly identify the upcoming expenses and the maintenance expenses and maintenance. And also, they have to follow huge process to calculate daily cost of the motorcoach depending on the route. That is why they are not able to directly identify the future expenses. When we consider about the employees also, they cannot directly identify how their salary created how much EPF/ETF they have allocated, and their salary increments according to their performances etc.

The first step is the focus of this research, which focuses on how to support the transition from a manual paper-based system to an automated private motorcoach management system and what features should be added to the current automated private motorcoach management system in order to improve performance. As the second move author established the identification of content of research papers that author have studied. Author prepared questionnaires and conducted the interviews with related parties as the third move. As the fourth move author analyzed and categories the new features that should be added to the prevailing automated private motorcoach management system. In the final move authors interpret the results of analysis and present the review and synthesis of information which authors analyzed in the research.
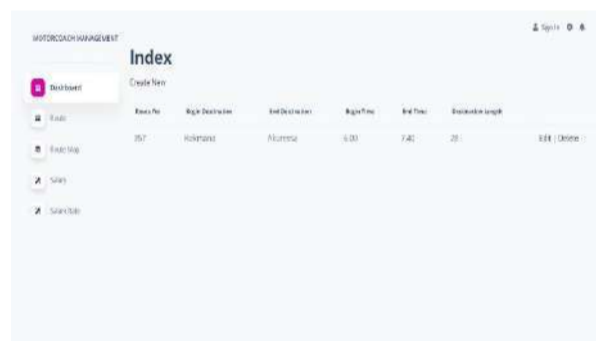

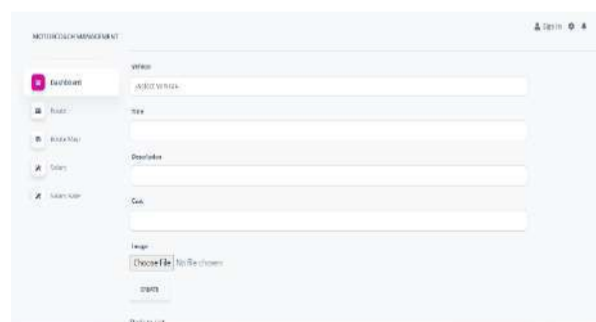Figure 1. Expected System - PMMS – Main Interface
Source: Author

Figure 2. Expected System - PMMS – Interface
Source: Author

4. Results and Discussions

This section shows the results of analysis. I have read more than 30 research papers regarding management systems and created the questionnaire and distributed the questionnaire to a set of 50 people and conducted interviews among 20 persons who are relative to the system. After analyzing the sample data, it was very clear that Private Motorcoach Owners, Employees, and Passengers are having problems while integrating with traditional paper-based systems as well as prevailing automates systems. The gathered data with the help of the questionnaire made it possible to clearly extract the final outcome and the decision which must be taken in order to accomplish the final output by what are the characteristics and features of the solution that must be think at most in order to emerge the best and efficient solution throughout the whole assumptions. Sri Lanka is a third world country which is still developing. When considering about the transportation sector it has a huge impact to the development of the country. But in the Sri Lankan transportation field most of the work is done manually.

The questionnaire and interview circulated was based on the close-ended questions. Author gave optional open-ended questions for further evaluation and research assistance. The responders mainly focused and answered mostly in a higher percentage for the bellowed mentioned questions;

A. Does your private motorcoach business has an active " Private Motorcoach Management System"
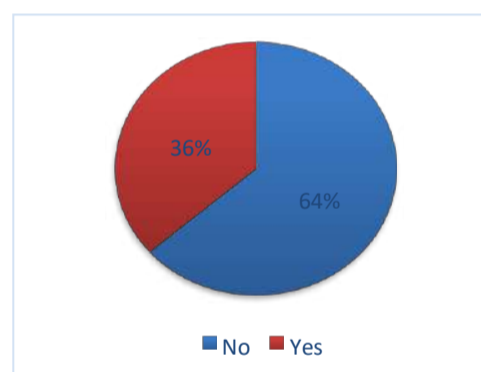
Figure 3. Availability of PMMS
Source: Author

According to the sample evaluation still 63.9% Sri Lankan private motorcoach owners don't have an active automated Private Motorcoach Management System. Most of the owners still working with traditional paper-based system and some work with both traditional and automated Private Motorcoach Management System. Only few private motorcoach owners fully depend on automated Private Motorcoach Management System. Because of these existing traditional as well as inaccurate automated Private Motorcoach Management System lead for many problems.

B. If your private motorcoach business has a "Private Motorcoach Management System" what is your satisfactory level of the current existing system?
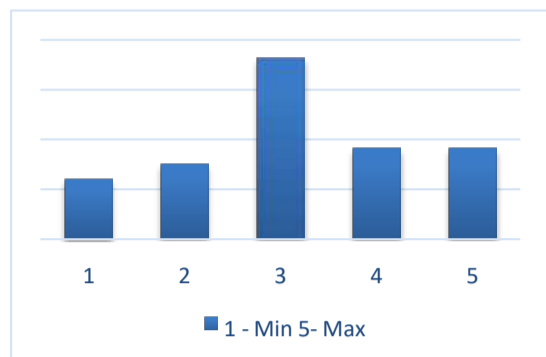
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Figure 4. Satisfactory level of prevailing PMMS
Source: Author

Around 40% of the respondents had medium satisfactory level of the existing system. This was due to lack of user-friendly interface and the compatibility of the system.

C. *Would you like to integrate with an "Automated Private Motorcoach Management System"*
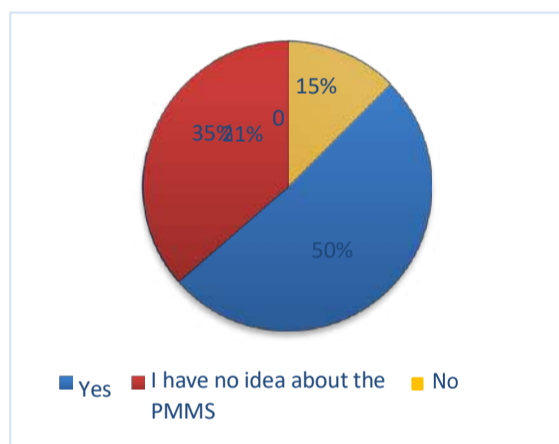

Figure 5. Likelihood to integrate with PMMS
Source: Author

50% of the responders suggest that they would like to integrate with fully functionalized automated PMMS and few were respondent as "no" to the question. But 35% had no idea about what a private motorcoach management system is. Lack of knowledge and attitudes about the importance of automated Private Motorcoach Management System is another factor why these still continue with the traditional paper-based system.

5. Future Enhancements

In this research the main aim is to identify and recommend how to aid in updating from traditional manual Paper Based Private Motorcoach Management System to Automated Private Motorcoach Management System by improving and perfecting the prevailing Automated Private Motorcoach Management System. The Automated Private Motorcoach Management System is a practical instrument for the transportation industry, and by expanding its capabilities,

we will be able to gain various benefits. As a result, paying attention to future improvement became crucial.

Because of the digital divide and lack of knowledge about the information technology infrastructure and most of the Private Motorcoach Owners in Sri Lanka still work with traditional paper-based system. So, the first thing these Private Motorcoach Owners should do is convert their traditional paper based Private Motorcoach Management System to the automated Private Motorcoach Management System.

Some Private Motorcoach Owners work with both traditional and automated Private Motorcoach Management System at the same time because of the issues that arise while using the automated system. Even though some Private Motorcoach Owners fully depends on automated Private Motorcoach Management System they are facing major issues while integrating with the systems.

The currently used automated Private Motorcoach Management Systems raise some issues while using it on cross-platforms. The system misbehaves if the viewing browser or platform of the web pages change. So, it will be very helpful for the future systems to be supported to display the web pages on any device as per its dimensions. And also, future systems can be developed as a mobile application providing all the services to register users as same as the web application.

Employee management, Salary management, Maintenance Management, Profit Calculation, Finance management still doing manually by motorcoach owners. So, it is a challenging task to a owner to manage the whole process and recording them. But if these tasks can do automatedly with a few intermediate of owners that will lead to a massive progress in private motorcoach management system and will lead to time saving and provide accurate data and effectiveness and the efficiency will grow up rather than manual system.

Online motorcoach reservation system helps passengers to book a motorcoach for their special tours. Online inquiries/ complain system helps passengers to send their complain or suggestions directly to the key person of the private motorcoach. Salary viewing process will help employees to view how their salaries are calculated and get a monthly salary report through the system. Financial management section leads to identify future financial needs and it notifies before they occur and get a proper idea about what the financial status of the asset. Cost calculation section helps to calculate cost by depending on the route and this will lead to allocate actual costs for future maintenance. Maintenance section records the whole maintenance, and this will lead to identify the upcoming maintenance and get ready before they occur. Profit calculation section will lead to get daily profits and monthly it generates the monthly profit report.

6. Conclusion

Private motorcoach transportation plays a vital role in everyone's day today life. This research was based on how to aid in updating from traditional manual Paper Based

Private Motorcoach Management System to Automated Private Motorcoach Management System by improving and perfecting prevailing Automated Private Motorcoach Management System. When analyzing the prevailing automated private motorcoach management systems, It is evident that there is room for improvement in several areas where we have the capacity to create the tools for better service than what is now provided.

The concept of the "Digital Divide" is severely restricted in Sri Lanka. Therefore, it is extremely difficult to bring about progress in small type of motorcoach transportation businesses. The effectiveness of the automated private motorcoach management system will also be impacted by managers', owners' employees' and passengers' lack of technological literacy or fundamental knowledge in some areas. Consider the fact that many organizations have neglected to take into account the high cost of technology, bad choices, competition, and the lack of a sound company strategy. This implies that in order to fully harvest and benefit from other aspects, an owner must be developed to their full potential.

One of the most important points to be made after reviewing all of the facts listed above is that the world is always changing. It only takes a moment to flip everything upturned, suggesting that we should always be aware. As a nation, we must advance in many sectors under the guiding principle of get together and move forward. It's not an individual who can enters to this technology but if the small, medium and large scale of private motorcoach owners get together and that make a huge change in our country for the success of private motorcoach transport services.

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Automated Car Service Management System to Make Industry More Efficient

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Abstract:The automobile maintenance and service industry is also witnessing the trend of people expecting to order online like other consumer goods and services these days. But it is a weakness that many leading vehicle maintenance service providers are still doing business based on paper works. Because of this, it appears that there is a minimum level of trust and willingness of the customers regarding the existing efficiency of the automobile maintenance and services sector. Due to this, the customers should spend their time and effort in vain, while the opportunity for the organizations to use their time and resources efficiently is also reduced. In the existing manual system, the ability to provide the necessary information to the customer immediately and to provide the most accurate information has been reduced. As an alternative to that, automating the existing manual system provides the space for organizations to successfully face a large customer attraction and business competitiveness. This automation provides an opportunity for customers to book an appointment and get services without the hassle that they expect and pay online, as well as get information about services and prices from home. This allows the organization to increase sales and avoid unnecessary labor losses due to the ability to offer discounts to frequent customers and carry out corporate marketing campaigns to attract customers. The purpose of this study is to limit the mistakes and wastages of not only consumers but also the automobile service industry by automating the existing manual systems.

Keywords: Automobile, Web-based System, Automate, Online booking, Reporting.

1. Introduction

Vehicle production goes back many years. Vehicle service and maintenance companies have also been established and maintained since that time. From time immemorial, vehicle maintenance and service companies have maintained their transactions and related data in books and ledgers. Therefore, the main problem that arises is the loss of vital data for the customer as well as the organization due to the misplacement or destruction of the ledgers, transaction books, and data. Other disadvantages are that the organization must manually write and embed all the data, missing data, making it difficult to find the information, as well as costing considerable time and money. Vehicle maintenance and service companies are always busy workplaces and the need for automated vehicle maintenance and service system instead of a traditional written data entry system has arisen.

The problem now is that there is no system in place to make a reservation for the service before purchasing a customer service through the existing manual system. It is a vulnerability in current systems. Customers have to wait in long queues, waiting for one customer to serve causes wasting customer time and customer money. One of the weaknesses of the current system is the lack of a systematic system for the customer to obtain accurate data on previous maintenance and spare parts used for their vehicle.

The main purpose of this research is to get rid of traditional transaction reporting and traditional service supplying methods and provide a formal theoretical and more accurate solution to satisfy the consumers who grant the services as well as organizations that provide services in a more convenient and efficient manner.

2. Literature Review

The strength of both technology and financial status is providing individuals wings to not only realize but also to fulfill their aspirations as we move toward a period when technology will predominate, and as the financial status will also rise through time. Shortly, there will be more automobiles, which will result in more cars needing repairs at mechanic shops. This will result in lines at the mechanic shop. The issue of long lines and waiting may become quite significant in the future. Development in the realm of service centers and garages is the Online Management System for Automobile Services. Any automobile owner will feel very convenient if they can use a website to find and contact the garages or service shops in their area. With the click of a button.(S. B. Hanamant, B. Dharmendra and P. Yash, 2018)

The Web will generally serve as the basis for numerous advancements. As we near an era when invention will be the driving force, the power of innovation is giving people wings so they may not only innovate but also meet all of their needs immediately. As India's population of vehicles grows, so will the quantity of vehicles waiting to be repaired at technician shops. The current situation will influence a chain at the repair shop. The problem of lengthy waits and queues can become quite significant eventually.

In the sphere of administrative centers and carports, the Vehicle Service System for Automobile Services represents a reformist development. Any vehicle client can use this website to locate local help centers or carports, contact them, and reserve an available slot with the selection of the necessary services. After making a reservation, the client will unquestionably be aware of the amount charged and the amount of time required for adjustments. Customers will also have access to a FAQs section to aid them with any questions. (Vigyani Singh, 2021)

The number of countries that produce cars has increased from a small number to a large number. While it has been largely consistent in other regions, the number of motor vehicles produced in the Asia and Pacific region has increased significantly over time. By the end of 2018, the Asia and Pacific area produced close to 52 million vehicles or around 55% of all vehicles produced worldwide. In 2018, China, the United States, Japan, India, and Germany were the top five automakers. Production rose by 26 and 33 percent, respectively, in China and India, following the regional trends mentioned above. With growth rates of just 2% and 1%, respectively, in the US and Japan. In Germany, the number of vehicles produced fell by 10%.

From more than 80 million units in 2010 to more than 100 million units in 2018, sales of all sorts of new automobiles, including used vehicles Following North America, where sales climbed by 30% from 20 million units in 2010 to 26 million units in 2018, is the region of Asia and the Pacific and the Arab States, where sales increased by 60% from 25 million units in 2010 to 47 million units in 2018. Sales climbed by 10% in the European Union (EU), from 19 million units in 2010 to 21 million units in 2018. Thus, due to the increase in the demand for vehicles, the demand for vehicle maintenance services and vehicle servicing has also reached a very wide level. In such a situation, it is clear that there is great growth in the amount and quality of the services that can be provided by an automated web application than the services that could be provided to vehicle owners through the traditional manual system. (Zhou *et al.*, 2020)

Each person is extremely busy with their business in the quickly expanding, fiercely competitive business world and is unable to take a break for even a moment. Customers would really prefer to receive services online and have all of their demands met. These days, the Automobile sector keeps its business records on written papers by handwork. They discovered considerable difficulties performing routine manual labor to handle their everyday chores. faces a number of challenges when performing manual tasks, such as managing records of day-to-day activities, receiving customer bookings, service data, staff details, management level details, and handling booking questions. As was already indicated, when they wanted to find quick services online, they encountered various problems with the outdated system. (Matheeban, 2017)

The way in which problems are addressed, the supervisor's comprehension of the client's complaints, the atmosphere in the customer lounge, and the performance of the vehicle following service all have an impact on the customer's experience. From the time the appointment is set until the customer starts driving the car again after servicing, the customer will begin to review the service. When the expected level of service and the actual level of service received don't match, either contentment or dissatisfaction results. Oliver (1980) noted that satisfaction results from outcomes that exceed expectations, whereas dissatisfaction results from outcomes that fall short of expectations. Therefore, when the service received does not live up to the customer's expectations, discontent sets in. All automaker is aware that customer satisfaction is a crucial battleground for competitive advantage and must do every effort possible to prevent this from happening.(Justus, 2021)

3. Methodology

The automated vehicle maintenance and service system aim to provide better customer service as well as improve the efficiency of the organization by providing appropriate solutions to the vulnerabilities that arise from the manual system. The automated system provides a new website for the company's transactions, the ability to make advance bookings for service delivery, the availability of customer vehicle maintenance, replacement of new parts, pricing, and service information as a document. Includes a range of services such as reminding customers via email about upcoming service seasons, advertising business promotional details, posting feedback, maintaining customer profiles, and making online payments.

Both quantitative and qualitative approaches are used to effectively determine the procedures and convey the requirements of System users. The main goal of data collection is to find information about vehicle owners and service station offices. The majority of knowledge is obtained through structured and unstructured interviews with subject matter experts by resolving the issue and finding pertinent documents using the documents analysis method. the problem was solved by examining the technologies, applications, and problems of applying knowledge management. Interviewing leading automobile service management officers and vehicle owners in the Colombo district allowed for the collection of all pertinent information, including all of the specifics and specifications. The objectives were developed following a thorough analysis of the applications of the automation vehicle service Management System's structure, flaws, and issues. This made it easier to develop a framework for analyzing effective automobile service management. evaluated academic publications on pertinent topics in this field. A Google Form with the necessary information was circulated to collect current issues and requirements. As primary data sources, existing automotive service management systems research papers, case studies, service reports, and the internet were all used.

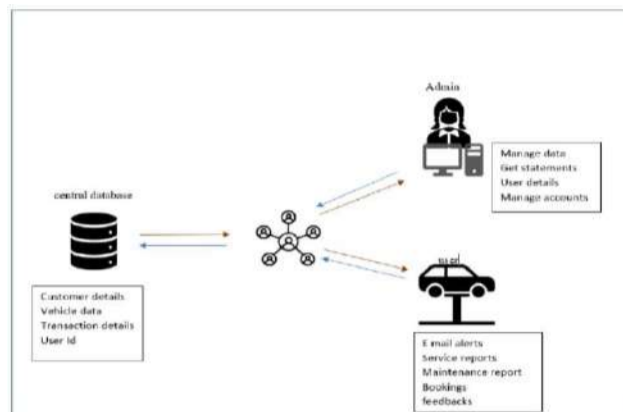The following diagram shows the conceptual model of the automated web-based car service Management System.

Figure 1. Conceptual model

As demonstrated in the figure the proposed system provides assistance for the service management officers, administration, and people who own the vehicles. admin will be able to manage all the services even including the stocks of materials in an efficient way. At the point when users want to make a reservation for servicing their vehicles, they can register their vehicles throughout the system and after logging in that enables them to book a slot for their service needs. After making reservations, the admin is able to see the booking details in the admin dashboard. All the bookings and service details and transactions will be stored in the database. As technologies that have been used for the proposed system are C#,.NET Framework, JavaScript, HTML, Bootstrap, MySQL, AJAX, and JSON.

4. Results & Discussion

Based on the interviews, field trips, and questions that have been conducted, the need for a fully automated automobile car service management system instead of the existing manual system as a solution to the problems that arose during vehicle servicing has been seen as very important. Finally, these analyses determined the key characteristics that may be implemented in an automated car service management system.

The system maintains two separate dashboards named admin and user. This system is undoubtedly a web-based system, that any vehicle maintenance and service provider can use to make their services more effective and efficient. Vehicle owners can experience the services as per their choice after registering their vehicles through the website. Among those services, many facilities can be provided such as booking appointments online, paying money, getting information, getting old service reports, taking details of previous payments, gain discounts. It also enables administrators to separately study online bookings, cash payments, transaction events, stock updates, and various service reports as well as customer transactions that occur during the day.

A. Registration Module

Vehicle owners have the ability to register in the system by themselves and the admin also has the ability to do user registration.

Figure 2. Registration Module

B. Login Module

To enter the system, users should use the login feature. Users and administrators should provide their username and password to log in to the system.

Figure 3. Login Module

C. Online Booking

When making a reservation for vehicle services, the owner should select the date and time first.

Figure 4. Online Booking

Then users can book the service by selecting the required services and paying the related fees online.
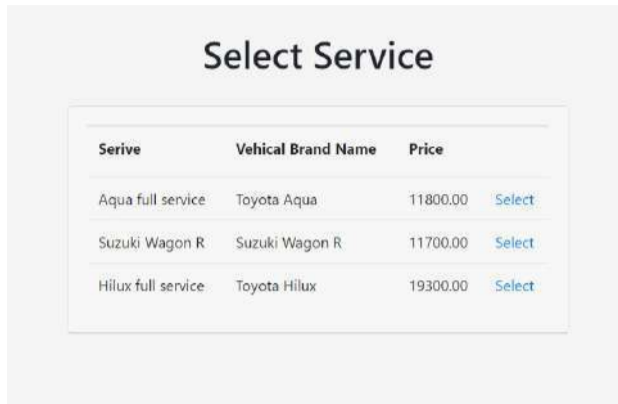
Figure 5. Select Service
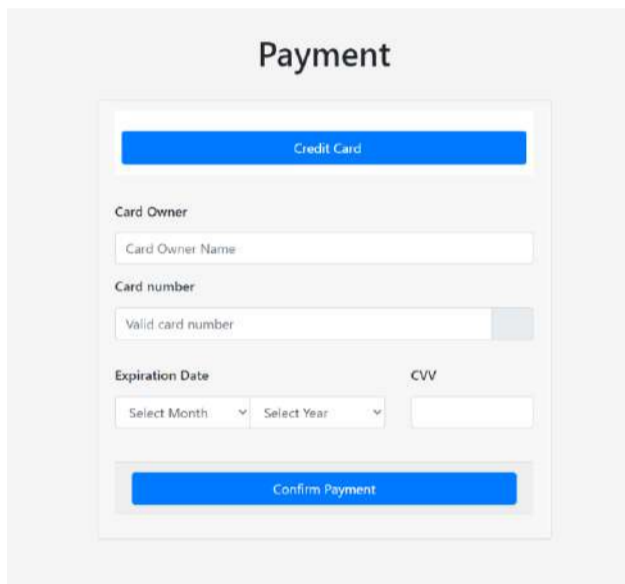
Figure 6. Payment

D. Inventory Managing

The availability of the raw materials required to perform the services and their re-order quantities and prices can be viewed through this system at any time required by the administration.

Figure 7. Inventory Managing

E. Reporting Module

Customers, as well as administrators, can get information like reports about the transactions done, services received, information about the services and consumptions done so far, customer information, etc.

Figure 8. Reporting Module

F. Feedback and messaging

The users can send messages to contact the administration and feedback can be used to inform the admin about the effectiveness and weaknesses of the services received.
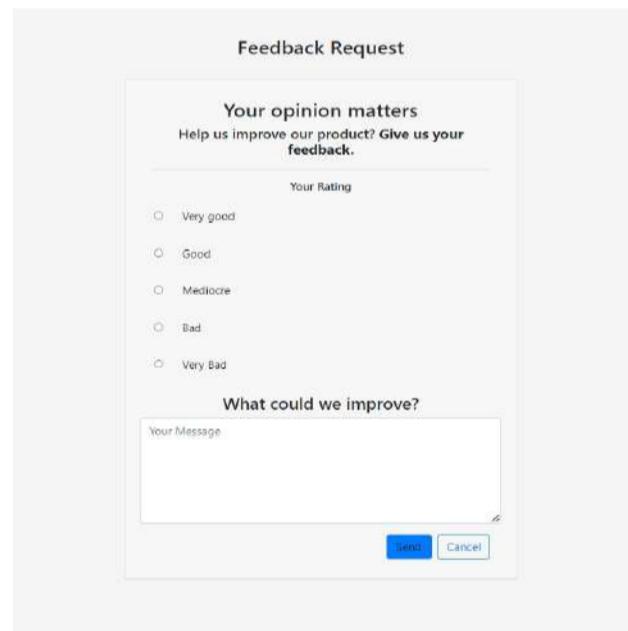
Figure 9. Feed back

G. Slot View

Through this system, the administration officer can clearly understand the amount of service currently received and the service capacity that can be provided further by checking the service slots allocated.
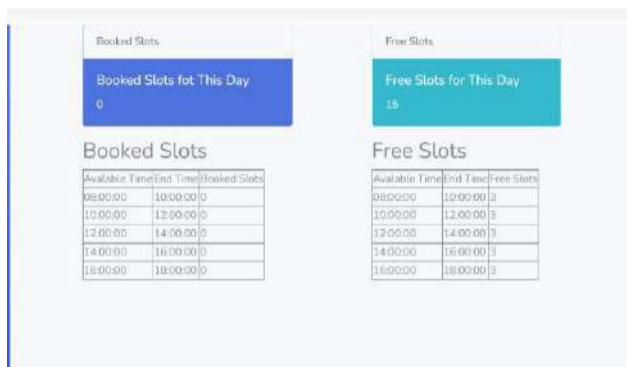
Figure 10. Slot View

The system generates vital resources for the administration as well as the users. With the help of this system, the administration may accurately deliver services to customers in the sector without wasting time on paper documentation.

5. Conclusion

The need to provide services without traffic jams is a problem for many car service providers. There were many service stations for that, but doubts have been raised about the efficiency of the services provided by them. Nowadays, it is seen that a lot of time and effort, as well as money, is spent going to get the vehicles serviced. Due to having to wait in long queues, it is also seen that vehicle owners are reluctant to get their vehicles serviced. Although there are many leading vehicle service centers in Sri Lanka, most of them still provide services to clients using traditional manual systems. This has resulted in many clients not getting the right information and services they need without delay. As a solution to this, this research discusses how an automated web-based system can make the provision of vehicle services efficient. As a solution to the current major problems, using this automated car service management system will save customers time, money, trust, and efficiency by providing the right information in the right way and by automating the booking and paying process online.

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SpiAuc: Development of an Online Platform to Sale the Spices in Sri Lankan Market

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Abstract: Sri Lanka's spice market is significantly impacting the global spice market. In the current context, farmers are encountering practical issues such as high production costs, difficulties finding international markets, and high margins from intermediate sellers. Moreover, farmers are less aware of reaching the international market due to several barriers. This paper presents an online user- friendly auction system that allows bidders and sellers to interact through an online platform. The proposed system is low-cost and includes many features such as price forecasting, complaint management, etc.

Keywords: Online Auction Systems, E-commerce, Price forecasting, time series

1. Introduction

The Sri Lankan economy is primarily based on agriculture. More than 70% of the population living in rural areas of the country is dependent on agriculture as the primary source of livelihood. The sector contributing to Sri Lanka has always been renowned for producing delicious spices. The spice sector is an essential sub-sector of the Sri Lankan economy, contributing 9% to agricultural GDP and exports (Central Bank of Sri Lanka, 2021).

The global reach of the online auction market allows buyers and sellers to overcome geographical constraints and purchase products anytime from anywhere over the internet. The online auction market provides consumers with a great advantage of low process, more excellent product selection, and greater efficiency compared to the traditional offline market. The objective of the online auction system is that the user can better choose their investment. All market participants would use price forecasts to make informed decisions. In the Agriculture field, Farmers must have a clear idea about how the market prices are moving forward to sell their product at a better price.

Most of the time, spice farmers are from rural areas, and they are not aware of available online opportunities in modern days. Also, due to the lack of study related to various worldwide markets, they have to sell their products in the local market. Further, many buyers and dealers of products are unaware of the production, quality, quantities,

and availability of different spice products. Buyers don't have time to spend buying the product in the market.

The best solution for this situation is the auction procedure. However, in the primary manual auction, a minimal number of the general public are involved. There is a chance of corruption and other factors for not providing transparent bidding. The manual bidding process restricts most interested bidders out of the city or country from declining their offer or interest as they are available on the day of the auction. Another flaw of this method is the piles of paperwork that must be maintained and kept safe for the future. They must keep track of the bidders and the sellers until their final settlement. It is a fatiguing and time-consuming process. So basically, No facility is present for the farmers to forecast market future price shifts. It limited direct access to merchants.

The real profit goes to the intermediaries, who buy up the farm products at almost giveaway prices and sell them at outrageous prices to the wholesalers. Farmer's unawareness of the market leads to crop losses while wasting their time, money, and hard work. Also, local farmers have low English literacy and cannot use the most available web applications. When selling their products, farmers must have a clear idea about how the market prices are moving forward to sell their products at a better price. Creating reliable preharvest price expectations and making postharvest storage decisions depend heavily on accurate forecasts. Without accurate forecasts of basis levels, it is impossible to make fully informed decisions about whether to accept or reject a given price and whether and when to store the harvest. So, there is a clear need for a system that enables users to predict price shifts more accurately and helps bypass the middleman by profiting the farmers according to their hard work.

Spi Auc is a web application that will provide the facility to the farmer(users) to sell their products at a fair price and in a better manner and provide value-added services to the bidders and sellers. This application will help bridge the gap between farmers and buyers by creating a market that enables farmers to connect buyers to sellers. The web application will allow the farmers to sell the products to the desired person by analyzing the price shifts in the market.

After login to the system, farmers can post the images and details of the product. The farmer can get the idea for a start margin price using predicted prices using historical data. Then the farmer can set a margin to start bidding by using graphs of forecast market prices. The buyer can select the product and bid accordingly. The bidding will have a specific time duration, which the seller will set. The product will be sold to the highest bidder at the end of the time limit. Or the farmer can close the bid for the desired price. If there is a problem in the last bid, the proposed system will get the latest second bid as the final bid. When placing the bids, the farmer will get notifications regarding the new bid. The users can communicate and pay through the system, and the system will also provide functions to add complaints and ratings.

The final product will be a simple and functional web-based graphical user interface to the users that is available in both Sinhala and English languages. The existence of Spi Auc is to raise awareness of the exploitation of middlemen in the agriculture sector through purposely overestimated deduction rates to secure their profit margins, leaving farmers with inadequate income. Through the novel system, farmers' financial power by providing a bidding integrated e-commerce platform to increase their income. Also, improve the accessibility of the market as well as accurate and latest market information by providing a transparent market information platform to the farmers and end consumers.

2.   Related Works

Nowadays, the online auction has become one of the fastest-growing modes of online commerce transaction; sellers and buyers have started preferring to go online for purchasing and selling products, respectively.

N. Kumar, A. Kumar, and S. Tyagi (2016) introduce the NAM portal that provides a single-window service for all APMC-related information and services. The proposed work includes commodity arrivals and prices, buy, and sell trade offers, and provision to respond to trade offers, among other services. According to the author, the proposed work help to the reduction in bookkeeping and reporting system with better monitoring and transparency. It also helps in the reduction of workforce requirements as tendering/auctioning process takes place through the system. A closer look at the research paper, however, reveals some shortcomings. Although it enables direct participation in the traditional local trade, reducing intermediation costs, the paper did not comprehensively discuss the system's user-friendliness.

A. Kolkova (2018) also thinks about the possibility of using technical analysis indicators in forecasting prices in the food industry compared with classical methods, namely exponential smoothing. This research paper confirms simple forecasting tools from 2009 to 2018. The analysis was completed using data on the primary raw materials of the food industry, namely wheat food, wheat forage, malting barley, milk, apples, and potatoes, for which monthly data from January 2009 to February 2018 was collected and analyzed.

The author argues that, while using indicators as a default setting is inappropriate in business economics, their accuracy is not as strong as the accuracy provided by exponential smoothing. Additional studies are required to understand the critical tenets of moving average forecasting.

Ivanovski. Z (2018) investigates the time series analysis's forecasting capacity to predict tourist trends and indicators. The authors found evidence that the time series models provide accurate extrapolation of the number of guests quarterly for one year in advance. Research results confirm that the moving average model for time series data accurately forecasts the number of tourist guests for the following year.

Most of the works above mention did not provide a way to predict the margin price of the agriculture market. Some related used time serial models for the price predictions. Still, they are unrelated to agriculture, and there are no available features to add their complaints and rating aspect of the products or users. Spi Auc web application would benefit both farmers and sellers equally.

This application eliminates intermediaries; hence it's a direct communication platform between the farmers and the buyers. However, this web application not only provides the highest price for the farmers but also possesses many additional features which serve the application as the most accessible, most reliable, and user-friendly application which would, in turn, help users who are new to this computer era. The Complaints and rating features forum allows users to post their perspectives about the product and the users. The price Prediction graph is provided the best margin price they could set for their products. In addition to all these facilities, the translation feature will be most beneficial for farmers who lack English literacy.

3.   System Design

Spi Auc will enable users to predict price shifts more accurately. The gap between the farmer and the buyer should be removed, and the middleman should not interrupt the marketing process.

This application directly works with cooperatives and farmers to bypass middlemen by profiting the farmer according to their hard work. This will result in better business from the farmer's point of view, and this application will connect the farmer with the world differently.

This web application contains four modules i.e Admin, User, Security and Authentication, and Reports.
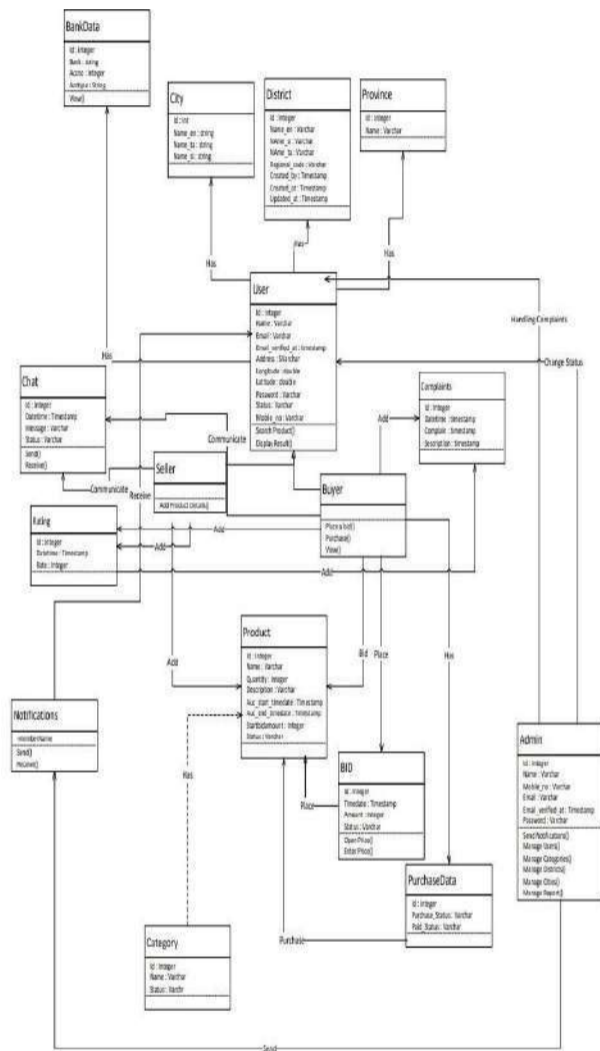

Figure 1. Use Case diagram of the system
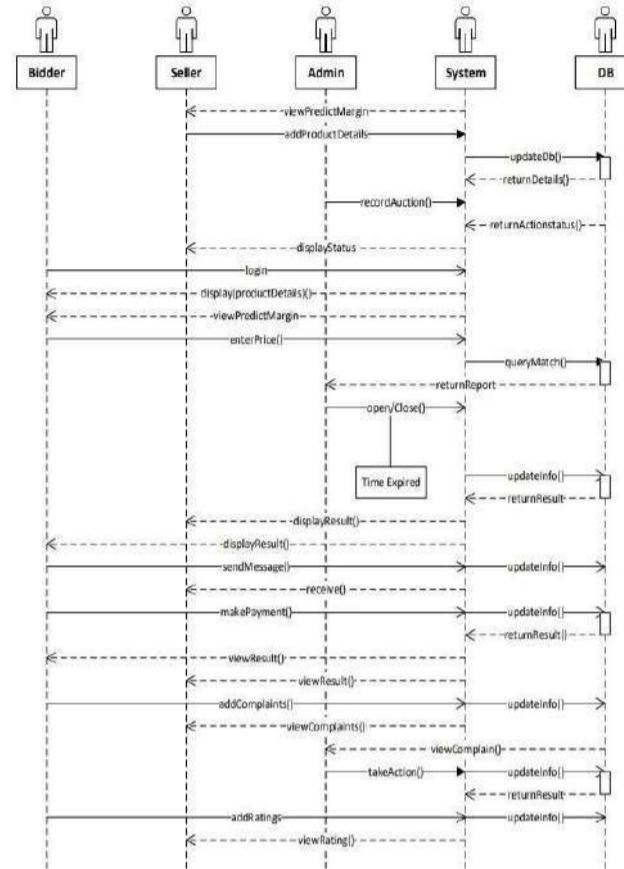Source: Author
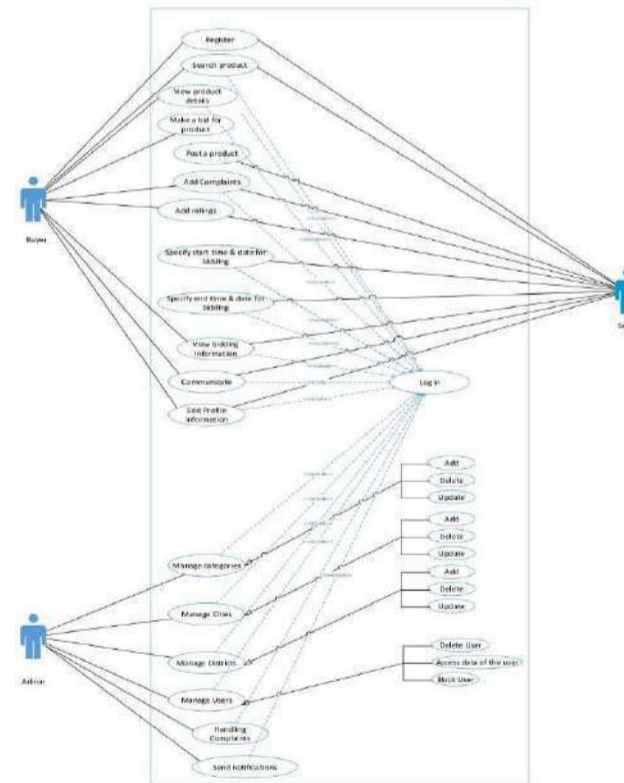

Figure 2. Class diagram of the system
Source: Author

Figure 3. Sequence diagram of the system process
Source: Author

Security and Authentication Module: It is the first phase of the application. Both users must (Seller and Buyer) first will have to register by using their details; otherwise, they won't be allowed for further process. Once the user signs up successfully, they can log in anytime using their registered is and password. All the transaction information regarding the auction and user personal details was encrypted, which prevents information leakage.

User Module: This is the second phase of the application. In this module, the seller can upload their product details along with images. Then the seller can set a margin to start bidding by using graphs of forecast market prices. Spi Auc has two user roles as Buyer and Seller.

Predicting prices – Moving averages are the method used in the price prediction of this web application. It calculates price averages over a certain period and automatically draws lines on price charts based on these calculations. The simple moving average is used in this Spi Auc. A simple moving average (SMA) adds the most recent daily closing prices and divides the figure by the number of days to create a new average for the next day. Each average is connected to the next, creating the singular flowing line.

Implementation – When sellers create an auction, they add the start margin price along with the product details. After bidding starts, the product will be sold to the highest bidder at the end of the time limit. The highest latest bid price regarding a product during the day takes to calculate the predicted market price for the next day. SMA is calculated in SQL for 5 days on the latest bid prices. This means each row will consider 2 rows before and after the current record, calculate the price sum and then divide it by 5. Since there are no rows before that, the logic remains the same for the first row, but only the 2 later records are calculated. Similar is the case for the last record where only the 2 previous records will be calculated since there are no records after that.

```
Algorithm
Begin

SELECT
 [Date]
 ,[Close]
 ,AVG([Close]) OVER (
   ORDER BY [Date]
   ROWS BETWEEN 2 PRECEDING AND 2 FOLLOWING
 ) MovingAverageFiveDay
FROM [TABLE]
End
```

Output is visualized to users as graphs in this application. It is observed that a simple moving average attains minimum error at the short-term period of 3 months; however, gradually, the error increases for the long-term period of 12 months. So, in this application, the time series used for price prediction is limited to 5 days.

On the other hand, buyers can view the uploaded products in the Dashboard. If the user wishes to buy the product, they must bid for it according to the base amount and time for the bid the farmer decides. If the product is on auction, the rules of auction and bid history can be viewed, and bids can be submitted for that product. The product will be sold to the highest bidder at the end of the time limit. Or the farmer can close the bid for the desired price. If there is a problem in the last bid, the proposed system will get the latest second bit as the final bid. When placing the bids, the farmer will get notifications regarding the new bids. The system can also get a notification about the auction's winner at the end. The users can communicate and pay through the system and the system will also provide functions to add complaints and ratings. The rating and the complaints will be displayed under each user. This will also help to get an idea about each user. A payment gateway is available for purchasing procedures.

Admin Module :
The admin module consists of five components.

i. Add new categories of products, districts, and cities.
ii. Take action according to the complaints of the users.
   This feature enables the admin to remove users if there is dissatisfaction. The admin handles the authority of controlling users.
iii. Maintain the status of categories and users.
iv. Cancel any auction if any violation or fraud activity takes place.
v. Allow the users to view the details of the products and monitor the progress of the various auctions.

Reports :
In this module, different actors can generate different types of reports according to their access.

4. Testing and Results

Spi Auc has mainly two user roles: Admin and the user. All the administration parts of the system are handled by the admin as shown in fig.4.

Figure 4. Admin Module – Site Administration
Source: Author
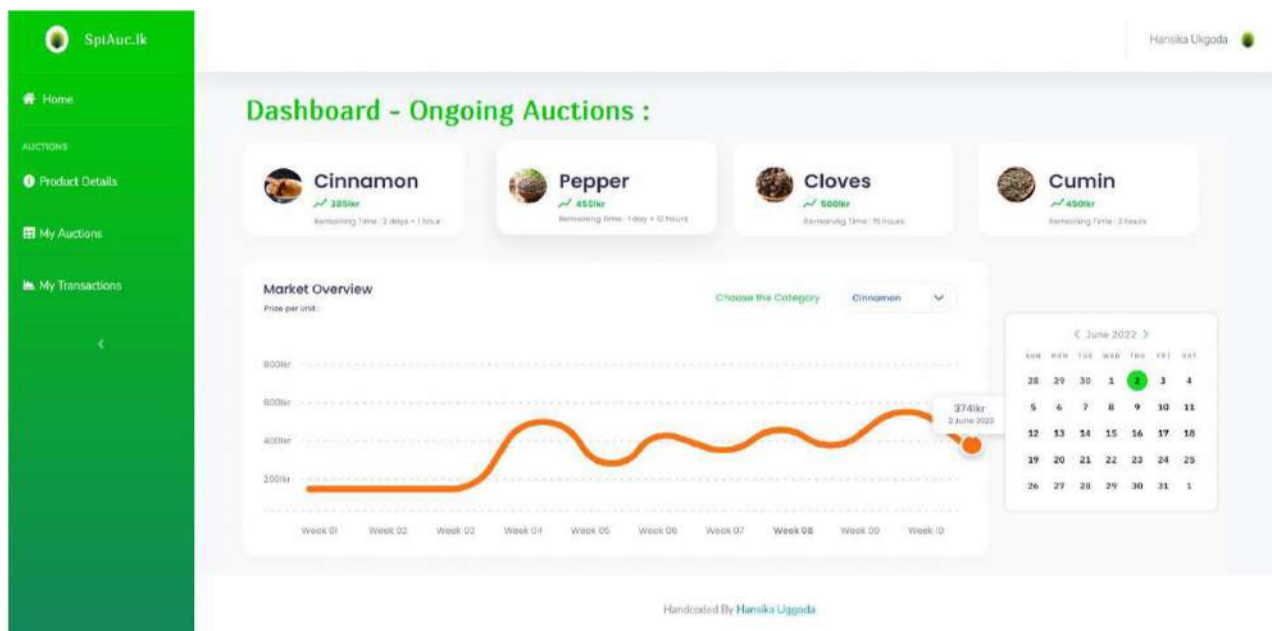
Figure 5. Home Page Source: Author

The administration is divided into two parts Site administration and User Administration. In Site Administration, all the cities and categories are handled. User administration allows the admin to take action regarding the complaints of a user. In the User Module, if the user is already registered, then enter the required details and log in. if a new user needs to fill in all required details as required in the register.

Sellers can set their start margin price using the price prediction graph. This graph shows the predicted price for the day according to the product category. Fig.6 shows the Dashboard that is available to both users.

Figure 6. Product details filling page
Source: Author

As well as the details of the ongoing auctions are displayed In the dashboard. So, this is convenient for both users.Fig.5 is for sellers, after successfully logging in to the system-seller can add their product details with a start margin price. Fig.7 shows the current bid product and all other bid product details uploaded by the seller. It also shows the latest bid placed by the seller for a particular product and the remaining time it takes to end the ongoing auction.

Figure 7. Auction details
Source: Author

The seller can search the category they wish to bid on, then add their bids. If they win the auction, they get a notification from the system, and then they can proceed to the payment procedure. After a successful transaction, both users can add their complaints and rating regarding the product or user.

5. Conclusion

This paper presents a simple and user-friendly online platform for farmers to sell their products in the international market. Compared to the traditional auction schemes, the proposed scheme is quick, reliable, and can be done anywhere.

Therefore, the result of this study is to develop an application that helps bridge the gap between farmers and buyers by creating a market that enables farmers to connect buyers to sellers. The price will allow the farmers to sell the products to the desired person by analyzing the price shifts of the market. Also, if there is dissatisfaction with a product or a user, both parties can complain, and the admin can take action according to the responses. Moreover, The proposed system will enable users to predict price shifts more accurately using the predicted price graphs based on the time series model. This will result in better business from the farmer's point of view, and this application will connect the farmer with the world differently.

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District Hospital Ambulance Management System

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Abstract: A significant issue in hospitals is the exchange of ambulance information and updates. The District Hospitals, who maintain Ambulance information as well as other information like drivers' and partners' availability, are also having problems with it. All these activities take place in the hospital office's transport department. The entire mechanism operates entirely manually. Today, government entities place a high value on the use of computers and information technology. Most government entities conduct their regular business utilizing manual processes. same in hospitals as well. Due to the workload, there will be a lot of confusion in the system when district hospitals are involved. As a result, there will be delays and information loss. Because district hospitals now use manual procedures for this, the suggested methodology and the associated program to construct an ambulance management system are pertinent and accurate. Therefore, it should be easier for the district hospitals to efficiently handle their ambulances.

Keywords: Emergency Service, Ambulances, Hospitals

1. Introduction

Ambulances are the most practical medical equipment now available in every nation. The health care industry heavily depends on ambulances. Ambulances are used to transport a patient to the closest hospital or healthcare facility in the event of an incident or if the patient is in a very serious condition. To maintain and operate the entire ambulance system in a country like Sri Lanka, manual handwriting procedures are still used.

Research Problem: Government hospitals are very numerous in Sri Lanka. District hospitals make up 19 of them. Some hospitals are situated in critical locations.

When there is an emergency, the majority of people use ambulances. When an event occurs, they make a call to the closest hospital to request emergency service. When this occurs, persons who are a member of the system must wait longer for an ambulance and the hospital personnel must check the vehicle logbooks of certain hospitals to see if an ambulance is on hand.

Therefore, it would be advantageous to create a web-based application for Sri Lanka's district hospitals so that they can manage their workload while also improving the quality of care they can give to their patients. The entire process of system management is automated with the aid of this system. The system's automation, which includes tracking ambulances as well as updating and tracking ambulance drivers' attendance to manage their vacations, distinguishes it from the existing system. The system also offers records of ambulance services and shows the date for the next planned service. The performance and maintenance of the ambulances will be improved. Having a well-kept ambulance available in case of emergency is also preferable.

Research Aim: The aim of this web-based system, however, is to quickly examine the availability of ambulances, including drivers and their partners, as well as to avoid leaks of the current method for releasing ambulances.

2. Literature Review

Sri Lanka's government provides a free health service in the form of Western medicine, which is practiced in hospitals throughout the country, and Ayurvedic medicine, which is practiced in one hospital in Colombo. The health-care system (Western medicine) is divided into two parts: preventative and curative. (Paskins, 2001) In Sri Lanka health care is provided via national hospitals and teaching

hospitals. A provincial general hospital is a general hospital with additional services. Each district has a single general hospital (referred to as a district general hospital) that provides care in the four major specialties as well as some subspecialties. Only the four major specialties are served by base hospitals. There are extremely few facilities in divisional hospitals, peripheral units, and rural hospitals, and they do not provide any specialist care. There are 19 District hospitals in Sri Lanka. (home, no date)

In Sri Lanka, there are currently no qualified emergency medical physicians. In 2012, however, a specialty training program for emergency physicians was launched. There is no formal structure in place for emergency medical technicians to be trained (EMTs). In the event of an emergency, Sri Lankans frequently take taxis or their own vehicles to the hospital. Ambulances are available at all the hospitals to transport patients between them. (Wimalaratne et al., 2017)

An ambulance is a specifically built, well-equipped vehicle that transports patients safely until they are handed over to a facility where they will get final care. Ambulance services are designed to save a person's life before they reach the hospital. (Nandasena and Abeysena, 2019)

When considering the ambulance drivers, they are working according to their duties. So, every ambulance has a driver and a partner. They are working for shifts. As a result of this sometimes hospitals fail too when finding an ambulance driver with a partner.

In hospitals the uses of ambulance are,

• To carry serious disease cases from smaller hospitals and maternity homes to the institution to which the ambulance is linked or to the Base/Provincial/Teaching hospitals directly.When a Family Health Worker summons the Ambulance, it is to transfer urgent pregnancy cases within the Ambulance's service area to the institution to which the Ambulance is linked.To carry similar cases from the institution to which the Ambulance is assigned, such as the Base/ Provincial/ Teaching Hospitals.Ambulances may also be used to transfer patients to any other hospital for the purpose of returning to a Teaching/ Provincial/ Base Hospital. Ambulances should not be utilized to carry

medical staff or for any other purpose unless the PDHS has given its prior clearance.

And, when hospitals need drugs sometimes, they are using Ambulances as a transport method. But the problem is with the use of ambulances hospitals can only transport small quantities of drugs from medical supplies division/divisional drugs stores on the return journey. Such drugs must be packed under the seats and drivers should be instructed not to load them. And there are some instructions for the drivers. There are two types of instructions, are daily and weekly,

***As Daily*,**

Clean and wash vehicles, Check the water level in radiator and oil level, Test breaks and lights, Check steering, Start the engine and listen for any unusual noises.

As Weekly

With used engine oil, clean the undercarriage, engine, springs, transmission, and steering, Cleaning the vehicle's equipment is also required, Cleaning the vehicle's equipment is also required, Battery terminals should be cleaned and tightened, Fill the battery cells with pure water to the necessary amount, On the move, look for rattles, loose bolts and nuts, and strange noises, All tools should be cleaned and oiled, and the air pressure on all wheels, including the spare, should be checked.

In Sri Lanka some hospitals in having 10 to 15 Ambulances. But some hospitals have only one to 3 ambulances. So, in that case, if there are any emergency cases, they must ask for an ambulance from another hospital. ('ManualDHPURHmanage.pdf', no date)

If there is any injury patient at a tertiary hospital who used an ambulance should have to get to the first health facility from the respective ambulance. IN that case, there are some assigned persons for an ambulance. They are, Ambulance driver, A hospital attendant or trained labourer should be detailed to accompany the patient. (A female attendant or a female labourer should accompany a female patient), The midwife should always accompany maternity cases. (Reynolds et al., 2021)

NHS ambulance system in London, are providing ambulance to the patient within 8 minutes of average time. The patient can make a call to 999 and they will have an

ambulance withing 8 minutes of time. Another thing is the have trying categorized each call to give the best response to the patients. According to that category one is for calls about people with life-threatening injuries and illnesses. For that category they planned to response withing 7 minutes of average time. The second category is for emergency calls. These calls will be responded an average time of 18 minutes. In this category stroke patients will get to hospital or specialists stroke unite quicker because they can send the most appropriate ambulance first time. Category three is for urgent calls. The patients who are getting staff treatments at their own home comes under this category. So, for that they response at least 9 out of 10 times before 120 minutes. The last category is for less urgent calls. In this category may be given advice over the phone or referred to another service such as GP or pharmacists. The less urgent calls will be responded to at least 9 out of 10 times before 180 minutes. The new system of NHS in England is focusses on ensuring patients get rapid lifesaving, life changing treatments. (National Health Service, 2017)

According to Ahmed Shaikh at el, in India most people are dies because the patient is not able to reach the hospital in time. With the use of GPS, they have developed an application that can reduce the waiting time of the patient and the ambulance driver. With the help of GPS, the location of the patient goes to the ambulance driver. For this the user and the driver must have a smart phone. When the user clicks the emergency button it will directly send its location to the ambulance driver. The main function of this project is to reduce the time between the patient and the driver. With that they trying to save someone's life. As technology they use Google map, Application programming Interface (API), android studio and the GPS connectivity are used. (Allfrey, 1882)

3. Methodology

However, this web-based system aims to quickly examine the availability of ambulances, including drivers and their partners. And, to avoid the leakages of the prevailing system. In a country like Sri Lanka, all government-provided healthcare, including emergency treatments, is completely free. The emergency services must be well-prepared for any emergency scenarios that may arise at any time or location. Additionally, hospitals need to be able to allocate better emergency services so that they can transport patients and administer first aid there. These activities are now being done by ambulance. The issue, however, is that the hospital cannot manage an emergency properly or get a better ambulance when one is needed.

It was discovered, with the aid of numerous research articles, what functions ambulances must perform in this healthcare industry. Additionally, to identify the issues, associated personnel created a questionnaire to gather information from the personnel who use ambulances in emergencies. With that, it was discovered that many patients had issues with waiting times, facilities provided by the ambulance crew, and their opinions of the current ambulance dispatching system. By communicating with the vehicle clerk of a few hospitals in Sri Lanka, were able to learn about all of their present procedures for dispatching ambulances. In that situation, determine the ambulance dispatching system's operation as well as the performance of the drivers' and their partners' duty rotations.

Observations are another technique for gathering data. Now, countries like Sri Lanka are seeing a lot of accidents. By keeping an eye on these situations, information that is required to design the system is gathered. In that situation, list the personnel who are involved with ambulances and the functions they do. Additionally, watched how they functioned in emergency situations and what each employee's duties were.

Analysis: Priority will be given to the technology for gathering data and analysing technique to identify the optimal plan for developing the system. Around the world, a variety of applications are used to manage the ambulance dispatching system and deliver high-quality care to patients. These apps helped identify the optimal system components that may be used. Additionally, in that situation, the problems with those applications were noted, as were the problems with gathering, understanding, and breaking down a system into its component elements. Numerous aspects, including aims, can be covered by system analysis.

Data gathering: Methodologies like interviews, questionnaires, observations, and referring to research articles were employed to collect the data. The system requirements and user needs were determined with the aid of that.

Interview: To learn more about the current method, questions were asked of both ambulance room employees and vehicle clerks. It is helpful in identifying the flaws and the current system operations. Through this process, the requirements that must be incorporated within the new system were achieved. and a series of questions to get the necessary information for the applicable field. as a result, learned about the data that is contained in the "Vehicle logbook". All vehicle information, including that pertaining to ambulances, was kept in a book called a vehicle logbook. This approach is still used by Kegalle Hospital, Kurunegala Hospital, Colombo General Hospital, etc to handle their vehicles. In that instance, the vehicle clerk must consult the vehicle logbook to designate the appropriate ambulance for each ward when one is required. There will be a waiting period in this scenario. If the patient's circumstances were risky, it might harm the patient. The failure to verify the availability of ambulance drivers was another flaw that was discovered during the relevant parties' interviews. These are the issues that the interviews revealed.

Questionnaires: Asking question from the relevant parties who are involved with the system will gain a better idea to full fill the requirements. So, for that created a google form with prepared questions to obtain the information form the relevant parties. In that case collected much information. The summery of the questionnaires is as follows.

Question	Got Responses		Response %
Are you male or female?	107	Male	53.3%
		Female	46.7%
Did you ever use an ambulance for like emergency situations?	107	Yes	60.7%
		No	31.8%
		Never	7.5%
Are there any problems when you are getting an ambulance?	104	Yes	55.8%
		No	44.2%
For what reason you use an ambulance?	106	Emergency situation	60.4%
		Normal situation	14.2%
		Never used	25.5%
Is the ambulance arrived at correct time?	106	Yes	30.2%
		No	31.1%
		Don't know/ Can't remember	7.5%
		Never Used	31.1%
Was the way you got into the ambulance suitable? (e.g. by walking, on a stretcher etc.)	105	Yes	56.2%
		No	11.4%
		Don't know/ Can't remember	32.4%
Overall, how would you rate the care you received from the ambulance service?	101	Excellent	30.7%
		Very Good	10.9%
		Good	18.8%
		Fair	6.9%
		Poor	29.7%
		Very Poor	3%
What do you think about the current ambulance dispatching system?	102	Excellent	30.4%
		Very Good	5.9%
		Good	20.6%
		Fair	4.9%
		Poor	30.4%

Figure 1 : Table of responses

In addition, inquire as to whether hospitals in Sri Lanka have an ambulance management system. Considering that, have received 52 responses. Most people claim that the ambulances' delay was caused by poor management of the current system.

4. Results and Recommendation

With the helped of the identified defects through the analysis it's better to have an automated ambulance management system for districts hospital. In that scenario with the help of this system can manage the ambulances in effective and efficient way. The entire system is a web-based application which is run in Realtime. To develop the system have using Node.js which can be run in chrome V8 engine. The system First register a new user into the system getting valid information's from the users who are really involved with the system. When logging in, the system must check the user's email address and password against the database of users. Officer in charge is the only authorized person that can update the system information's. So, he can be able to review and update of the details about the ambulances and details of drivers and their partners. He Must be able to include service records of the ambulances. The clerk is the second authorized user who can request the approval form the Vehicle officer to make changes in the system.

The driver and their partners can only mark the attendance and the review of their information's such as the days of they have been in worked and the number of vacations that they can have for a period of month. It because of if they have authority to update the records, they can mark their attendance at any place. So, in this system the area that they can access is limited.

If any ward wants an ambulance, they can request an ambulance through clerk to the officer in charge of vehicle. After the approval of the officer in charge clerk can release the ambulance through the system .at that time the message will pass to the driver who is available.If the record room request after the completion of month of period, the system generates a full report of ambulances Such as leaving times arrival times and the destinations and the service records to the Record room via email. And, if administration office requests a full report of drivers including their partners from the vehicle officer through clerk the system must be able to send a full report of drivers via email to the administration office. Entire system is as follows.

User registration: First user must have register to the system by providing valid information's such as valid passwords and email. The user must be aware about the limitation of the system and user must log in to their limited areas.

User login: After successfully register into the system user can access to the system that they have authorized paths of the system.

Data entry: When successfully log in to the system authorized users can update the details. Officer in charge of vehicle can add remove everything in the system. But the driver only can update and check the details. All the ambulance records should be entered by the officer in charge who manage the entire system.

Data deleting or modify: Officer in charge of vehicle only the person who can delete or modify data in the ambulance and drivers' data bases.

Data releasing: The data can be release only officer in charge of vehicle. By giving the authority of the system.
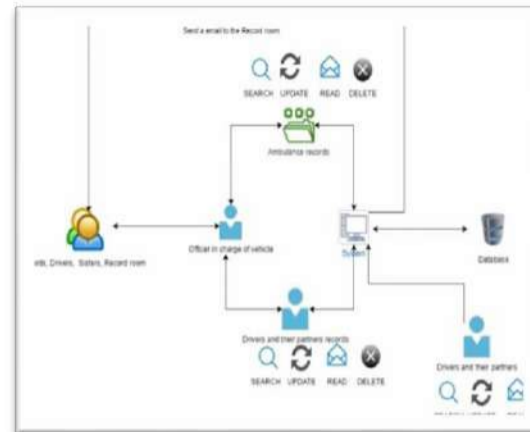

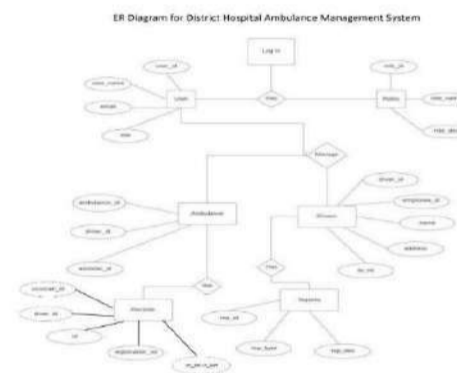
Figure 2 : Proposed system

Figure 3 : ER diagram
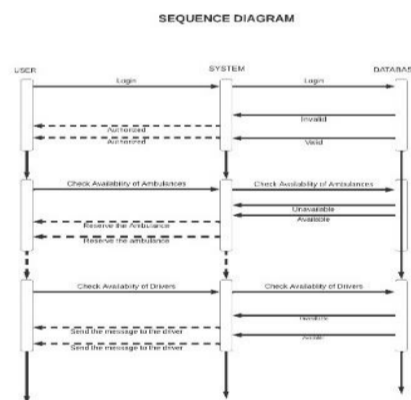

Figure 4 : Sequence diagram.

5. Conclusion

More than 15 district hospitals exist in Sri Lanka. Therefore, manual ambulance dispatching is still in use at all hospitals. It requires a lot of waiting time. That is the

issue most patients are currently having. The hospital staff may thereby lessen their workload with the aid of an automated ambulance dispatching system and deploy the appropriate ambulance at the appropriate moment with no waiting periods. Additionally, patients will benefit from receiving first aid in case of an emergency.

Acknowledgment

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Problems faced by staff and patients in Anuradhapura Teaching Hospital due to the existing system and how to overcome those problems

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Abstract*: The current situation in Sri Lanka is facing various difficulties for the patients as well as the hospital staff. In the past, due to the Covid-19 virus situation in the country, the patients, as well as the hospital staff, faced various difficulties. This study is based on the current traditional paper-based system's problems and solutions for the problems of Anuradhapura Teaching Hospital, the main hospital in Anuradhapura District, Sri Lanka. Due to this current system, the hospital staff, as well as the patients, are suffering greatly during the Covid-19 season and in the face of this fuel shortage. The information for this study was found through a Google form. And the hospital staff as well as the patients have participated in this study. This study cites 7 main problems in the current system. Compared to other countries, Sri Lanka still does not seem to go beyond traditional practices. But the purpose of the researcher is to find a technical solution to solve the problems. This study mainly studies the current funding issues in the Anuradhapura Hospital and possible solutions from an IT perspective. It is an automated web- based software. The software can solve the existing problems in the system. Also, the researcher has provided*
12 features that the web-based software should have. Following these, how to solve the existing problems will be found in this study.

Keywords: *Hospital problems in Sri Lanka, patient's problems, healthcare worker's problems, Government hospital.*

1. Introduction

Technology has changed the world. Technology has affected education, medication, social life, etc. there are many people in this world that don't like using technology and won't use it only for an important thing. Hospitals have been greatly impacted by technology. But sometimes people use traditional methods and don't want to get away from it. So, The researcher found one problem in Anuradhapura teaching hospital. Anuradhapura teaching hospital doesn't have a proper ward management system. Therefore, patients and healthcare workers are facing many problems. So, Researcher introduce an automated ward management system for Anuradhapura teaching hospital for the cause helping ward speed up their processes. The automated ward management system is a computer-based system that helps manage the information related to patient and their

healthcare. A Ward management system is introduced to solve the complications coming from managing all the papers works of hospitalization with confidentiality. An automated ward management system provides the ability to manage all the paper works in one place, reducing the work of staff in arranging and analyzing the paper works of the patient.

Currently, Sri Lanka faces an economic crisis and Covid-19. There are more problems in the country (fuel problems and electricity problems) Main problem is that due to the existing Covid 19 epidemic and the current situation of the country, patients face many difficulties in choosing a hospital for patients. Also, when choosing a hospital for Covid patients and other patients, it is not possible for patients to determine exactly how many beds they have at home. In our proposed system, we hope to solve these issues as well. Compared to other countries, Sri Lanka still does not seem to go beyond traditional practices. But the purpose of the researcher is to find a technical solution to solve the problems. The grant objectives of this study are to reduce patient time wastage. Reducing staff wastage, reducing paper wastage, and finding solutions to various problems faced by patients and staff. These are the research questions.

1. What are the problems faced by hospital employees and patients in using the traditional system?
2. What are the required features of an automated ward management system?

2. Literature Review

Perhaps Medicine has been greatly impacted by technology. Health information technology (IT), such as computerized physician order entry and electronic health records, has the potential to improve the quality of health care (McCullough et al., 2010). But sometimes this industry uses traditional methods and doesn't want to move away from them. For that reason, the hospital staff and patients seem to face many difficulties.

A. Problems faced by hospital staff and patients in using traditional management systems

Due to a lack of proper data entry and retrieval procedures, the hospital ward system documentation process contains several problems. Overcrowding stressed staff, and delays at specific points of data entry can all lead to decreased dependability and accuracy. Due to weak documentation

processes and overcrowding, drug management and distribution in present hospital ward systems has their own set of problems. These factors can lead to medical malpractice. (Dasanayake et al., 2018).

B. Features of an automated ward management system (solutions)

Consider the position of hospital receptionist. Logging into the database, registering the patient, checking the patient's report, accessing prior records, and editing the patient's records are some of the needs of the receptionist. The nurses will take care of the patient once the registration is completed. The nurse also needs system access to execute a variety of tasks, including gaining access to the database, examining the patient's records, searching for records, allocating the patient to a ward and a bed, and submitting daily health readings. Following that, the doctor must use the system to access the database, examine the patient's report, upload the patient's diagnostic summaries, search the patient's history records, and submit the prescription during the patient's examination. The MySQL database is designed to keep all patient records structured, quickly updated, searchable, and secure to satisfy the following objectives. It has produced a variety of tables for gathering admissions data, drug charts, treatment data, various health factors, and laboratory test results. The patient ID issued by the system is used to link the tables (Dasanayake et al., 2018).

C. New ward management technologies

RFID - The usage of mobile technology, such as radio frequency identification, can aid in the implementation of these ideas (RFID). Smart tags (RFID) and data processing may now be combined into a single integrated system thanks to today's modern technology. RFID is a groundbreaking technology that offers a sophisticated answer to a wide range of business problems, including those in the healthcare industry (Chowdhury and Khosla, no date). The latest ward management tool is use RFID. It can further describe as an RFID-enabled platform for monitoring patients, and ward staff and locating medical equipment forward management. The platform enables real-time monitoring and object tracking, ward statistical reporting, and intelligence and analytics provisions. A unique feature of their proposed platform is that all individuals, including ward staff, are tagged, and constantly monitored for their locations. This enables individual-to-person physical contact in the event of an outbreak and provides an immediate and effective response to reduce the risk of infectious disease in the hospital (Cheng and Kuo, 2016). The researcher does not consider so many technical things in the system he is expected to develop. The reason for this is that the Anuradhapura Hospital does not have the infrastructure to develop so much technology. And because such technologies are still unfamiliar to countries like Sri Lanka. The researcher also pending a degree in information

systems, where he focuses more on analytical skills than technical skills.

BARCODES - Barcode technology is used primarily to identify the patient. Barcodes are used in the hospital for other things. The drug storage system is barcoded. Pharmacy staff uses a scanner to measure the stock level in the ward and then order medications for the ward. Barcodes are stored electronically in the pharmacy, and everything has an ID number. Ordering is done online after someone has counted the stock by hand. (Dawson, Fisher, and Heslop, no date). Although the researcher intends to use the barcode technology in the proposed system only for patient identification, the researcher did not pay attention to that technology, as barcode machines are relatively expensive, and the system is relatively complex. Barcode technology speeds up the process somewhat. But the researcher hopes to identify each patient by a registration number system. Also, the researcher sets up this system only for his final year project.

D. Admission Process of patients

Every patient admitted to the hospital must go through a proper admission procedure. "They can come in by a variety of routes: by ambulance directly to the ward, they can go through the emergency department, it can be an elective or scheduled admission, but there must be an admission procedure." This is where the patient's clinical history begins. The clinical history is regarded as "continuous." Everything you do becomes a part of the record. However, "keeping a paper record is not the most efficient way to discover information; it frequently gets misplaced, and everyone records in a different format."(Dawson, Fisher and Heslop, no date)

As mentioned in the survey mentioned above, since many technical equipment's are not available in Anuradhapura hospital and this software is developed for the final year project of the surveyor, not much technical equipment is used in this system. And solutions have been presented to suit the Anuradhapura Hospital and as per the advice of the staff and patients.

3. Methodology

The qualitative research approach researcher used in this study within a framework of a survey research design. The convenienceence sampling method technique is used as for sampling technique. The target population of this study was the employees who are working in the Anuradhapura teaching hospital (doctors, nurses, receptionists) and Patients who have gone to Anuradhapura Hospital for treatment. Primary data from this study was gathered through google form via a questionnaire. The researcher captured 52 responses in the Anuradhapura area. People said they all went to the Anuradhapura hospital for different purposes. And one person said he didn't go to the Anuradhapura teaching hospital. Total population of 19

nurses, 3 doctors, one receptionist, and 28 patients who went to treatment and work for Anuradhapura general hospital. The data was collected using employees and patients from various distances in the Anuradhapura area. The third phase is design. And the final phase is testing). The researcher identified the problems regarding the entire system of Anuradhapura teaching hospital. And take the responses of the employees and patients who went to the Anuradhapura general hospital. All the problems who give through the survey are accepted by the employees and the patients. From the patient perspective researcher ask, "Do you face these problems at Anuradhapura Hospital when you go for treatment?". The researcher provides 7 questions regarding the current system. All the facts are accepted by the patients who went to the Anuradhapura general hospital for the treatments. Other than that, from the employee perspective researcher ask, "What are the weaknesses in the existing ward and patient management system?" Researcher provides 7 questions regarding the current system. All the facts are accepted by the employees (nurses, doctors, receptionists) who went to the Anuradhapura general hospital to the work. The researcher provides the solutions regarding the overcome the issues that I mention in the survey. All the solutions are accepted by the employees and the patients who went to the Anuradhapura teaching hospital. The researcher asks, what types of features are required for the proposed system. And researcher provides the features according to his opinions. All features are accepted by the employees and the patients who participated in the survey. The researcher used the rapid application development method for the project. (The first phase is planning. The second phase is requirement gathering.

4. Results and Findings

Firstly, the researcher mentions the population of the study, Researcher captured 52 responses in the Anuradhapura area. 51 people said they all went to the Anuradhapura hospital for different purposes. And one person said he didn't go to the Anuradhapura teaching hospital. Total population of 19 nurses (37.3%), 3 doctors (5.9%), one receptionist (2%), and 28 patients (54.9%) who went to treatment and work for Anuradhapura general hospital. The highest representation of the population was the patient who went to the treatments in the Anuradhapura teaching hospital. Its percentage is 54.9%. Those percentages and frequency are contained in table 1.

Table 1

NO	Role of the person		
	Respondents	Frequency	Percentage
1	For residential treatment (as a patient)	28	54.9%
2	As a doctor	3	5.9%
3	As a nurse	19	37.3%

4	As a receptionist	1	2%
5	Other	0	0

A. What are the problems faced by hospital employees and patients in using the traditional system?

From the employee's perspective - The researcher asked the respondents about 7 problems with their current system. More than 50% of respondents to this survey acknowledged these issues from the employee's perspective. The full result is contained in table 2. Table 2

NO	The limitations of the employee's perspective		
	Respondents	Frequency	Percentage
1	Waste of paper .	23	100%
2	Waste of patients' time.	23	100%
3	Waste of staff time.	23	100%
4	Problems in distribution of medicines in the ward.	15	65.2%
5	Problems in providing a ward bed to the patient after going to the hospital.	19	82.6%
6	Not knowing by the guardian immediately upon discharge.	16	69.6%
7	When a patient dies, his guardian cannot know it immediately.	17	73.9%

Firstly, the researcher considers about the problems faced by the employees who work in the Anuradhapura general hospital by using the entire system. Here the researcher asked the employees to select one or more of the problems they had. Every problem the researcher submitted to the survey was accepted by more than 50% of the employees as a problem they faced while using the entire system. The researcher takes the first issue as "paper wastage". Of the 23 employees who were initially considered in the survey, 23 said they had a problem regarding paper wastage. It is 100% as a percentage. The current system of the hospital is completely paper-based. Therefore, it appears that the waste of paper is at a high value, although it is the opinion of every employee who participated in the survey. The researcher takes the second issue as "patients time wastage". Of the 23 employees who were initially considered in the survey, 23 said they had a problem regarding the patient's time wastage. It is 100% as a percentage. As we all know time is the most important thing for all of us. We all try to reduce time wastage all the time. In the existing paper-based system, patient's time wastage is very high level. All employees said the patient time wastage happens through the existing system. The researcher takes the third issue as

"employees time wastage". Of the 23 employees who were initially considered in the survey, 23 said they had a problem regarding employee time wastage. It is 100% as a percentage. As we all know time is the most important thing for all of us. We all try to reduce time wastage all the time. In the existing paper-based system, employee's time wastage is very high level. All employees said the patient time wastage happens through the existing system. This may be due to repeated entry of some patient data.

The researcher takes the fourth issue as " Problems in the distribution of medicines in the ward.". Of the 23 employees who were initially considered in the survey, 15 said they had a problem with the problems in the distribution of medicines in the ward. It is 65.2% as a percentage. Medicines are the most critical thing in the ward. We must use the medicine in an effective manner in the ward. The researcher takes the fifth issue as " Problems in providing a ward bed to the patient after going to the hospital". Of the 23 employees who were initially considered in the survey, 19 said they had a problem regarding the problems in Problems in providing a ward bed to the patient after going to the hospital. It is 82.6% as a percentage. In the current system, some patients must stand in the wards for most of the day. But there are free beds for patients in other wards. The reason for this is that the doctor cannot know the number of patients in the ward before the patient goes to the ward. The researcher takes the sixth issue as " Not knowing the guardian immediately upon discharge". Of the 23 employees who were initially considered in the survey, 16 said they had a problem regarding the problems in not knowing the guardian immediately upon discharge. It is 69.6% as a percentage. It is a very important thing. The researcher takes the seventh issue as " When a patient dies, his guardian cannot know it immediately". Of the 23 employees who were initially considered in the survey, 17 said they had a problem regarding the problems when a patient dies, his guardian cannot know it immediately. It is 63.9% as a percentage.

From the patient's perspective - The researcher asked the respondents about 7 problems with their current system.

NO	The limitations of the patients perspective		
	Respondents	**Frequency**	**Percentage**
1	Waste of paper.	26	92.9%
2	Waste of patients' time.	28	100%
3	Waste of staff time.	27	96.4%
4	Problems in the distribution of medicines in the ward.	23	82.1%

More than 50% of respondents to this survey acknowledged

these issues from the employee's perspective. The full result is below (table 3).

Table 3

5	Problems in providing a ward bed to the patient after going to the hospital.	27	96.4%
6	Not knowing the guardian immediately upon discharge.	27	96.4%
7	When a patient dies, his guardian cannot know it immediately.	22	76.6%

As mentioned above, here too all the patients agreed to all the problems. Therefore, it can be clearly said that these problems are present in the existing system. Here, the researcher was also directed to the questions asked by the employees.

B. What are the required features of an automated ward management system?

From the employee's perspective - Researcher, if Anuradhapura Hospital needs an automated ward and patient management system to mitigate the above problems, what features should it include? asked. Below are the responses received there. These responses are from the employee's perspective.

	Respondents	Frequency	Percentage
1	Add patient details	22	95.7%
2	Patients can check their medical history at any time.	19	82.6%
3	Ability to quickly send a message/email to the patient's guardian.	20	87%
4	Ability to check how many beds are empty for patients from home (in Anuradhapura hospital).	17	73.9%
5	Do all the admission procedures using the computer.	19	82.6%
6	Manage all the ward details.	19	82.6%
7	Add, delete, and modify wards.	17	73.9%
8	Manage Account Details.	21	91.3%
9	manage the ward's inventory (medicines inventory).	20	87%
10	Ability to calculate how many beds are available in the ward.	18	78.3%
11	Auto-select the ward for the patients according to the doctor's opinion.	19	82.6%
12	generate the words monthly reports in the specific period.	19	82.6%

responses from the teachers. Firstly, the researcher hope to consider the "can add patient details" feature. It is accepted by the Anuradhapura teaching hospital's employees (95.7%) who participated in the survey. Add all the details means, that if the patient creates the account, he has the ability to enter all the details into the system that is required.

Firstly, the researcher hopes to consider the " patients can check their medical history at any time." feature. It is accepted by the ss teaching hospital's employees (82.6%) who participated in the survey. This is a very useful feature of the system. To enable this feature, the system must be able to include soft copies of the patient's past medical records. And in this questionnaire, the surveyor asked another question from the nurses. That is, "When a patient is hospitalized for a medical condition, can you always make inferences about the patient's past medical history?" Then the response of most of the employees was that it was very hard to get such an understanding. It accepts 78.3% of employees who participate in this survey. This shows that having all the old medical records of the patient is very useful for the doctor and nurse. Thirdly, the researcher hopes to consider the "Ability to quickly send a message/email to the patient's guardian." feature. It is accepted by the Anuradhapura teaching hospital's employees (87%) who participated in the survey. It is very important for the patient and his guardian. Fourthly, the researcher hopes to consider the " Ability to check how

many beds are available for patients from home (in Anuradhapura hospital)." feature. It is accepted by the Anuradhapura teaching hospital's employees (73.9%) who participated in the survey. It is very important for the patient and his guardian. Ability to check how many beds are empty from home (Anuradhapura Hospital) for patients. This feature is very important for the patient. This quality is very important during the last corona season. And due to the current shortage of fuel, it can be said that it is important here. Fifthly, the researcher hopes to consider the " Do all the admission procedures using the computer." feature. It is accepted by the Anuradhapura teaching hospital's employees (82.6%) who participated in the survey. It is very important for the patient and his guardian. It reduces time and paper wastage. And it improves the efficiency of the system. Sixthly, the researcher hopes to consider the " Manage all the ward details." feature. It is accepted by the Anuradhapura teaching hospital's employees (82.6%) who participated in the survey. It also reduces time and paper wastage. And it improves the efficiency of the system. Seventhly, the researcher hopes to consider the " Add, delete, and modify wards." feature. It is accepted by the Anuradhapura teaching hospital's employees (73.9%) who participated in the survey. It also reduces time and paper wastage. And it improves the efficiency of the system. Next, the researcher hopes to consider the " Manage Account Details." feature. It is accepted by the Anuradhapura teaching hospital's employees (91.3%) who participated in the survey. Next, the researcher hopes to consider the " manage the ward's inventory (medicines inventory)." feature. It is accepted by the Anuradhapura teaching hospital's employees (87%) who participated in the survey. All ward has a small medicine inventory. Sometimes they faced very difficult situations of not having a proper management system for the inventory. They can't calculate the entirmedicalne needs of the ward. The next researcher hopes to consider the " Ability to calculate how many beds are available in the ward." feature. It is accepted by the

Anuradhapura teaching hospital's employees (78.3%) who participated in the survey. Due to this feature, patients can resolve the discomfort. And this is very important for the doctor in assigning a bed to the patient. Next, researcher to consider the "Auto-select the ward for the patients according to the doctor's opinion." feature. It is accepted by the Anuradhapura teaching hospital's employees (82.6%) who participated in the survey. Due to this feature, patients can resolve the discomfort. And this is very important for the doctor in assigning a bed to the patient.

Lastly, the researchopeshope to consider the " generate the words monthly reports in the specific period." feature. It is accepted by the Anuradhapura teaching hospital's employees (91.3%) who participated in the survey. It is also helpful for the management team in the Anuradhapura teaching hospital to take a proper decision. As well as inventory reports can be directly used by the account team in the hospital. And it improves the accountability of the

inventory. These are the main features of the proposed automated ward management system for the Anuradhapura teaching hospital.

From the patient's perspective - Researcher, if Anuradhapura Hospital needs an automated ward and patient management system to mitigate the above problems, what features should it include? asked. Below are the responses received there. These responses are from the patient's perspective (table 5).

Table 5

NO	The required features from the employee's perspective		
	Respondents	**Frequency**	**Percentage**
1	Add patient details	26	92.9%
2	Patients can check their medical history at any time.	28	100%
3	Ability to quickly send a message/email to the patient's guardian.	28	100%
4	Ability to check how many beds are empty for patients from home (in Anuradhapura hospital).	27	96.4%
5	Do all the admission procedures using the computer.	27	96.4%
6	Manage all the ward details.	27	96.4%
7	Manage Account Details.	27	96.4%
8	Ability to calculate how many beds are available in the ward.	27	96.4%

As mentioned above, only the features that should be included in this system were examined from the patients themselves (employee's perspective). As mentioned above, most of them liked each of those features. Those percentages are shown above. All that was presented by the researcher was accepted by the patients and the employees who went to the Anuradhapura teaching hospital.

The solution from the IT perspective - The solution proposed by the researcher is to create a web application capable of solving the above-mentioned problems and having the above-mentioned features for the Anuradhapura teaching hospital. Researcher hopes to use the following technologies to create the web application. The proposed ward and patient management system were built using ASP.NET 4.5, MVC architecture, and C #.NET programming languages, with Microsoft Visual Studio 2017 used as a development environment. The database server is Microsoft SQL Server 2018.

Asp.net- Asp .Net is a free server-side technology developed by Microsoft. ASP.net decrease the amount of code required to process large and secure applications. It provides a rich toolbox in the Visual Studio development environment. It has the ability to easily deploy on Windows servers.

HTML- Hyper Text Markup Language is a client-side programming language used by the client to view the contents of a web browser page.

JAVA Script- JavaScript is an object-oriented dynamic language that is used to interact with the client and respond to the client's actions.

CSS- The Cascade styling sheet is used on the client side to format HTML pages and defines how the content of the web page is presented in the browser.

JQuery- JQuery is a JavaScript library that is small and lightweight. The goal of jQuery is to make it easy to utilize JavaScript in web applications.

Bootstrap- Bootstrap is a front-end framework for developing websites quickly and easily. Bootstrap is a framework for creating responsive designs.

This is the proposed solution's floor chart for the process of patient admit discharging that is created by the researcher (fig. 1.).
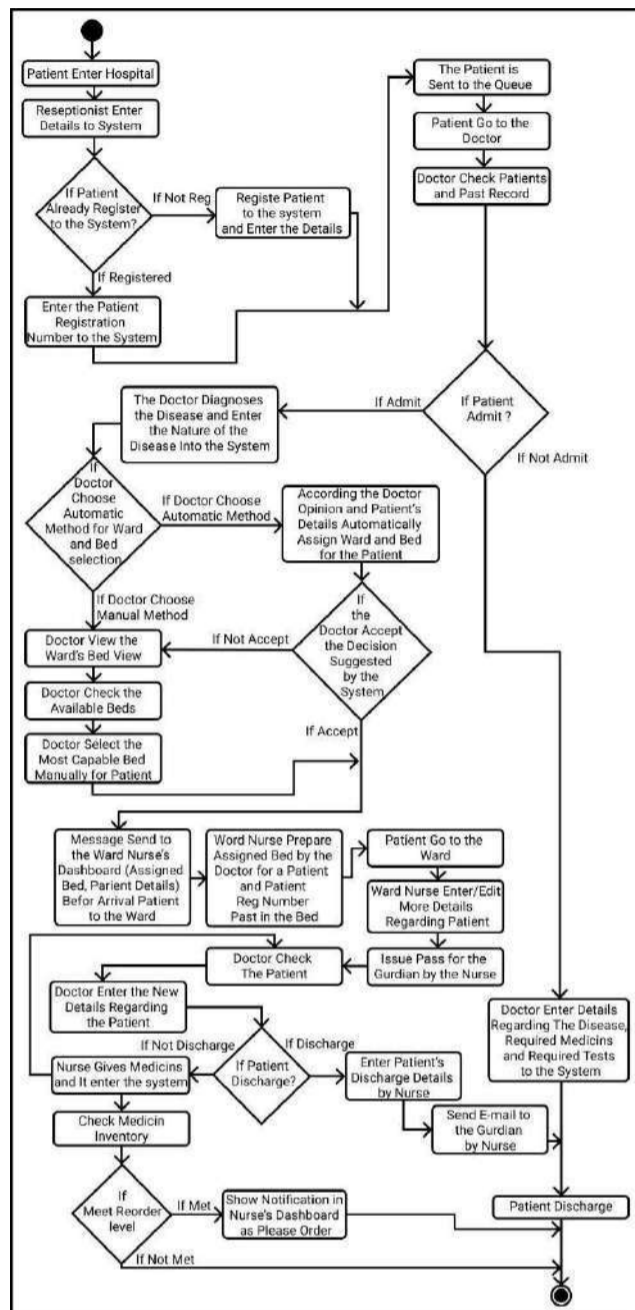
Figure 1. Researcher's main proposed solution process floor chart (The process of the patient admission to discharge in the web application).

The process in other words. Firstly, the patient enters the hospital and the receptionist enters the patient's details. If the patient already registered to the system and enter the patient's registration number into the system. If the patient is already not registered to the system receptionist adds the patient into the system and creates the patient's account. After this step patient adds the queue by the receptionist.

After the patient's attempt, the patient goes to the doctor for the treatments. After that Doctor checks the patient and if the patient has past medical records in the system, the doctor also checks the records as well. Atter doctors must take diction if the patient admits or, not into the hospital. If the doctor's opinion will be not admitted, the doctor enters the details regarding the patient's disease, required medicines,

and required tests into the system that gives to the patient. After allocating the medicines and patient will be discharged. If the doctor thinks the patient must admit it, the doctor diagnoses the disease and enter the nature of the disease into the system. There are two methods that can follow choose for the ward and bed selection for the patient by the doctor. These are the automatic bed selection method and manual bed selection method. The doctor can choose any of that methods. If the doctor chooses the automatic method, according to the doctor's opinion and patient's details automatically assign a ward and bed for the patient. In this phase consider the more things to assign the bed. Those are how many free beds in the words in the ward, the patient's medical condition, and the priority level of the patient (ex- in the critical level person he also add under the high priority level) there ate 3 priority levels in the system (high, medium, low). Also, the doctor can ignore the result that recommends through the system. He has the capability to ignore the automatic result and again goes to the manual method. If the doctor chooses the manual method for the bed selection, the doctor can view entire bed views of the hospital and he has the ability to visible how many beds are in the free status. And the doctor can manually assign the bed for the patient after considering the nature of the patient. After the assigned bed for the patient can go to the assigned ward and bed. After assigning the bed to the message sent to the ward nurse's dashboard (assigned bed, patient details) before arrival patient to the ward. And nurse can prepare the bed for the patient and pest the registration number in the bed before arriving the patient in the ward. After the patient arrived at the ward, the nurse take some more details regarding the patient into the system. After this phase ward nurse gives passes to the patient's guardians to come to the ward.

If the doctor comes to the ward round for check the patient, the doctor checks the patient and, the doctor enters the new medical details regarding the patient and required tests and medicines. After the assign the medicines to the patient it automatically reduces the wards inventory (All wards have a small medicine inventory). If one of the medicines is meet reorder level auto-generate the notification to the nurse's dashboard. And she has the ability to send the order to the pharmacist through the system. This all works must do researcher's proposed system. If the doctor decides the patient can discharge doctor can discharge. After the discharge nurse can add the discharge details to the system. End of all procedures automatically sends the email to the patient's guardian by the nurse. This is the researcher's main proposed solution.

In addition, the patient can register the system at the home, and they have the ability to visible how many beds are free in the Anuradhapura teaching hospital. And the system can create the monthly reports in the ward and inventory. While creating this system, we must take care of the security of the system. Therefore, the passwords of all accounts must be encrypted in this system.

5. Conclusion

As the researcher mentions above, Technology has changed the world. Technology has affected education, medication, social life, etc. there are many people in this world that don't like using technology and won't use it only for an important thing. Hospitals have been greatly impacted by technology. But sometimes people use traditional methods and don't want to get away from it. So, the researcher found one problem as it is in Anuradhapura teaching hospital. Anuradhapura teaching hospital doesn't have a proper ward management system. Therefore, patients and healthcare workers are faced many problems. There are so many problems faced to use the existing system. Those are, paper wastage, patient time wastage, staff's time wastage, problems in the distribution of medicines in the ward, problems in providing a ward bed to the patient after going to the hospital, not knowing the guardian immediately upon discharge, when a patient dies, his guardian can't know it immediately. Those ate the problems faced by the employees and the patient in the Anuradhapura general hospital by using the existing paperbased system. These were confirmed by the survey participants.

The solution to these problems is to develop a web-based application that can solve the problems mentioned above. Following are the features that this web-based application should have. Those are, can add patient details, Patients can check their medical history at any time, Ability to quickly send a message/email to the patient's guardian, Ability to check how many beds are empty for patients from home (in Anuradhapura hospital), Do all the admission procedures using the computer, Manage all the ward details, Add, delete, and modify wards, Manage Account Details through the system, manage the ward's inventory (medicines inventory), Ability to calculate how many beds are available in the ward, Auto-select the ward for the patients according to the doctor's opinion and, generate the words monthly reports in the specific period. These were confirmed by the survey participants. It is clear that a webbased application with these features will minimize the above problems.

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Towards IoT: Development of an IoT-Based Smart Elder Care System

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Abstract: Providing elder care necessitates input from a variety of sources, which the use of digital technology can aid. Both hardware and software are potential technologies that can be integrated into elder care. Some elders spend the last part of their lives alone in home or elder homes. Furthet, they forget their medicine schedules, and diet plans. Soers face various troubles. There are several impacts such as burglary threats, and daily home threats.So, this system built for create the safe zone to elders. these are the focus areas, Comfort, Health, Location, Safety, Wellness. Monitoring systems for the elderly collect a variety of information, including,movement,temperature, behavioral and sleep patterns, and more. The data provides critical insights into a senior's health and daily life to careers and medical professionals.

Depending on the rules of the senior living community, medical alert devices can be utilized at home or in the community. Many have emergency buttons or sensors that detect emergencies such as fires or falls. Depending on the aging monitoring system, calls to the police or caregiver can normally be made directly or indirectly.

Keywords: Activity detection through camera, Web based monitoring, Physical engagements, indoor temperature analysis, Danger detection, Abnormal behavior detection

1. Introduction

In society, there are group of people called "The Elders". They are the oldest group of people in any society. They are getting helpless when they get old. So, their children or guardians must pay more attention on them. Because some elders need the support of a third-party person to fulfill their needs and wants. With that case, there are some places, called "Elder's Home", which provides all the facilities to the elder people and look after them very well.

The elder's home is very much useful place because they provide great responsible service to the elders. So, if the family going out on somewhere, their elders might not be able to go with them sometimes. Therefor those elders can be going to the elder's home and getting their service, help of protection safely. In that elder's home, their helpers who always ready to serve their customers (elders) all the time. They provide foods, medicines, and helping them to fulfill their all the needs and wants.

However, from these kinds of elder's homes do not use modern technology to give customers a better service and ensure their safety. And also, there are some doubtful areas that needs to be updated on the traditional elder's home procedure as well.

Here, we suggested developing and implementing an IOT Based Smart Elder Care Home system that can reduce the doubtful areas and ensure the elder's safety increasingly. It will be a web-based application that can be connected to the elder's home staff, elders, and elder's guardians. With that system, all the parties connected to this process will have quality benefits in an effective way.

This system can remind the users of mealtimes, medicine times, and other things that could be reminded of. And also, it will detect the unusual situations such as gas leak, fire, and other dangerous situations and make some precautions automatically. This system can implement in homes and elder homes. as a first level, this system implements to the elder's homes. Around the world people research about this problem and implement various kind of systems. this is a huge problem in the world.

Some countries give the priority to the elderly. Let consider the many things that such follow for them. Major changes in population structure worldwide result from decreased fertility and many countries have been transforming into aging societies. An elderly is experiencing several difficulties in living due to physical and mental declines. Such changes impact two major indices reflecting good quality of life healthiness and access to decent medical services. Moreover, lack of medical.

personnel, demographical and geographical problems are significant barriers of medical service improvement. According to the study performed by The Economist, it has been estimated that 22.3% of population will be aged 65 or over by 2100, Elder care normally consists of three groups of people including caretaker (elderly), caregiver and medical staff. As family member is considered as a caregiver, a study indicates that caregiving is already a part of most workers' daily lives.

Providing elder care requires consultancy from several sources and it can be improved by digital technology application.

Potential technologies that can be integrated into the elder care include hardware and software. Wearable devices were initially used for fitness tracker and currently applied to medical services. Several vital signs such as heart rate, blood pressure and pulse oximeter are normally measured by the devices available in the market. Those readings are then delivered to the caregivers or medical staffs. Surveillance cameras are usually used for indoor and outdoor monitoring, respectively. The devices are connected to form the IoT via data communication. The caregiver's or medical staff's mobile phone or desktop computer install an application that facilitate data display, processing, and settings to yield health monitoring. Artificial Intelligence (AI) and robotic are another field of interests and can be applied to the elder care. However, each of the technologies has its own limitations and concerns. Several opportunities include cost reduction, preventive medicine promotion, medical education, stress and anxiety relief and service diversity.

2. Motivation

This system is more effective for people than the available systems in the industry. There are systems that works like this way but not effective. These Systems are available for online video conferencing and Danger detection People use these kinds of systems but without any innovativeness, this system includes, Monitor the elders and their Abnormal behaviors detection

However, caring for someone from afar poses its own set of issues, modern technology, such as caregiver alert systems and geriatric monitoring gadgets, may provide you with peace of mind and a helping hand.

Many counties use this for people with disabilities.
It is understood that effective care allows the elderly and disabled to live comfortably at home with complete confidence and peace of mind for themselves as well as their family members and relatives. This can be provided by combining existing or emerging technological solutions to enable seamless learning of the elderly and disabled's living patterns in order to provide personalized care in a proactive manner by monitoring and analyzing daily activities and alerting healthcare providers and relatives when early warning signals appear in order to avoid emergency situations. A sample application of smart home technology with a variety of networked sensors is described in this study. Although this is a quite simple example of smart houses, it demonstrates how smart homes could alter all aspects of the elderly and disabled's daily lives. We want to upgrade the prototype system with a software application and a set of sensors in the future to and generate sensor activity patterns to assess and predict changes in the monitored person's daily activities.

3. Related Works
Providing elder care need input from variety of sources, which can be aided using digital technology. Both hardware and software are potential technologies that

can be integrated into elder care. Some elders spend the last part of their lives alone in home or in elder homes. So that elders face various troubles. Sometimes they forget their medicine schedules, diet plans. There are several impacts such as burglary threats, and daily home threats. So, this system built for create the safe zone to elders.

In the face of that situation lot of countries going to smart elder care home solutions. because of they all need to protect and keep their parents or whoever of they love. so, during that situation innovative elder care systems are born day by day. but only a few systems can fulfill the requirements properly. now let's research the systems that have been developed in this regard across the universe.

Big data is crucial to the development and use of IoT devices. In turn, the phrase "big data" is used to refer to data analytics programs that use a large volume of data. Data analytics allows to determine the best solutions or predicted scenarios to acquire a competitive edge. In contrast, these commonly used smart gadgets make it easier for us to carry out our daily duties while data is being collected for business and optimization objectives, providing a win-win situation. Smart sensors, for instance, allow for the monitoring of a home's heating.
Device manufacturers may assist power suppliers in using data to forecast electricity use and can also provide consumers with tips for effective electricity use. (Breur, 2015) By 2023, the number of IoT devices is anticipated to surpass that of non-IoT devices due to the spectacular growth of IoT devices. By 2040, it is predicted that there will be close to 140 billion IoT devices, compared to a relatively static number of non-IoT devices. The expected rise of both IoT and non-IoT devices is seen in (Shenoy, 2020).The IoT gadgets will develop enormously and have an unavoidable impact on our everyday lives if the projection is even somewhat accurate. However, as these technologies are developing quickly and predicting becomes challenging within a timescale of 20 years, projections out 20 years should only be used as a guide.

IoT sensors can perceive, think, and act by communicating with one another, sharing information, and making decisions. The typical IoT components are displayed in The fundamental tenet of the Internet of Things is that every domain-specific application interacts with domain-neutral contributions, and that devices and actuators instantly link to one another in every region. IoT is anticipated to be utilized in smart homes since it enables its users to remotely operate their appliances while away from home and automatically open their garage when they arrive at their gates, switch

on the fan when the temperature rises, and inform them if there is a gas leak in the kitchen.

Although the elderly and disabled prefer to remain in their homes, it is nevertheless necessary to regularly monitor their health and activities so that assistance may be given right away in an emergency. In essence, smart homes are high-tech structures designed to facilitate domestic task automation, simpler communication, and increased security. They can improve the lives of the elderly and disabled by enabling them to remain in their homes, where they feel comfortable, as they have been designed to cater to their unique requirements. Additionally, they can assist careers in raising the standard of the services.

There are four basic issues with home automation systems: poor manageability, rigidity, difficulties attaining security, and high cost of ownership. The main goals of this project are to build and construct an IoT-based home automation system that can automate and control the majority of household appliances via a user-friendly web interface. WiFi technology is used by the proposed system to connect its scattered sensors to a server for home automation, giving it a high degree of flexibility. This will improve the capability of updating and system reconfiguration while lowering the deployment cost.

The home appliances are managed using a system based on the GSM network through SMS, as seen in the controller for interfacing the appliances is an Arduino board. To accomplish this interface, certain peripheral drivers and relays are used. The user interface device is a smartphone. The system leverages additional technologies to deploy the app and the visual programming tool "App Inventor" to create the user interface. Based on user commands, the program produces SMS messages and transmits them to the Arduino's GSM modem. The user is able to manage household appliances thanks to this. The technology has the same costs and reliability issues as SMS. The interface is also pre-programmed and cannot be modified according to the devices.

technological advancements have resulted in smart homes for aged care. On the other hand, it satisfies the actual needs of the elderly today. The elderly is physically and psychologically vulnerable when compared to young individuals. The smart home for senior care is a good response to this problem, and it may be able to meet the demands of the elderly for self-sufficiency. The development of smart homes for senior care in China, on the other hand, is a policy-driven product. In the beginning, intelligent technology was employed to better address the needs of the elderly, but the pace of advancement was slow. China responded by issuing a number of policy documents, including the Instruction to Promote Internet Plus Plan, the Action Plan for the Development of Smart Health and Elderly Care Services (2017–2020), and others. Since then, smart home pilot programs for elderly care have sprung up all over the country. The rapid development of China's smart

home for senior care is undeniably influenced by state regulations. Although the policy-driven nature of China's smart home for senior care has a lot of advantages, it has also resulted in some negative consequences. China's smart home for senior care is a policy-driven product rather than a demand-driven one, which has the obvious disadvantage that many elderly people do not understand smart homecare. As a result, the demand for smart homecare among the elderly is low. The elderly is generally price sensitive when it comes to clever items, and they have high expectations for their convenience. As a result, they have a poor level of self-efficacy when it comes to using intelligent technologies. Furthermore, people have a hard time envisioning how intelligent technologies may help them live better lives. In China, these characteristics have a detrimental impact on the elderly's general awareness of and demand for smart homes for senior care.

Many countries have developed various devices for elderly using IOT. prices here depend on the use of these devices. these data, collected over several years, underscore the importance of IOT technology.

IoT Technology – The Internet of Things (IoT) has been getting interests from both academic and industry. The key concept of the IoT is to connect numerous attached devices together via data communication over computer networks, such as the Internet, without human intervention, and to provide better services based on the collected data and processed output. There are currently several domains which that deploy the IoT, such as smart homes, smart industry, ogistics and health care. Moreover, it is estimated that there will be over 25 billion IoT devices. Key required capabilities of each device are data measurement and communication. In case of elder care, several devices such as wearable devices are attached to the elderly in order to measure their vital signs. Additional devices may be attached to several locations in their home to capture more data such as movement, temperature, and humidity. All devices are then connected to the computer server by means of data communication. The server consists of some computer programs which follow the users' requirements. When some events are triggered, some actions will be automatically conducted such as temperature adjustment, warning, and emergency call. Several IoT applications focusing on wearable devices together with relevant case studies are provided.

This section examines how IoT-based smart home systems might assist solitary persons with physical or mental difficulties, such as the elderly, people with disabilities, and other people with special needs, in their daily lives. The section focuses on smart home technologies that are now available and their applications for the elderly and disabled in some countries the government is involved in this problem. Southern European countries, despite significant levels

of underinsurance and a shortage of home-based and residential care, the family's duty for care provision is still emphasized Southern European countries and regions have just recently implemented more extensive elder or long-term care policies. The complex central-local interplay in Italy, has hampered the implementation of new, more comprehensive care programs due to welfare state limits.

According to the Administration on Aging, the number of individuals over 65 in the United States will quadruple to 69.4 million by 2030, accounting for 22% of the population. Historically, 43% of adults over the age of 65 join a nursing home for at least one year, yet according to a survey conducted by the Health Care Financing Administration (HCFA), 30% of the elderly would "rather die" than do so (HCFA Thousands of families are affected each year by the financial and emotional stress of such relocations. Individual sensing and automation components can be configured to transform a legacy home into something of a full-time caregiver by giving them an integrating' mind' with enough intelligence to coordinate and direct their behaviors for the good of the client, using emerging home sensing and control technologies, integrated through emerging networking and information transfer protocols, and managed by intelligent, adaptive systems.

Each countries uses different technology and commonly uses Arduino IDE to develop this system.
The C programming language was used to create the software for this project. The Atmel Studio IDE [16], which supports all of Atmel's microcontrollers, was utilized. Although the Arduino IDE is the most popular IDE for developing with the Arduino hardware and has a range of peripheral drivers, we chose Atmel Studio for more precise timing control, code efficiency, and debugging ease.

4. System Design

The web-based home automation system mainly consists of three modules the server, the hardware interface module, and the software package. The figure shows the system model layout. The server and hardware Interface module use Wi-Fi technology to communicate with each other. The same technology uses to login to the server web-based application. The server is connected to the Internet, so remote users can access server web-based application through the Internet using compatible web browser. Software of the latest home automation system is split to server application software, and Microcontroller (Arduino) firmware. The Arduino software, built using C language, using IDE comes with the microcontroller itself. Arduino software is culpable for gathering events from connected sensors, then applies action to actuators and preprogramed in the server. Another job is to

report the and record the history in the server DB. The server application software package for the proposed elder's home automation system, is a web-based application built using asp.net. The server application software can be accessed from internal network or from internet if the server has real IP on the internet using any internet navigator supports asp.net technology. Server application software is culpable of, maintain the whole elder's home automation system, setup, configuration. Server use database to keep log of elder's home automation system components, we choose to use XML files to save system log.
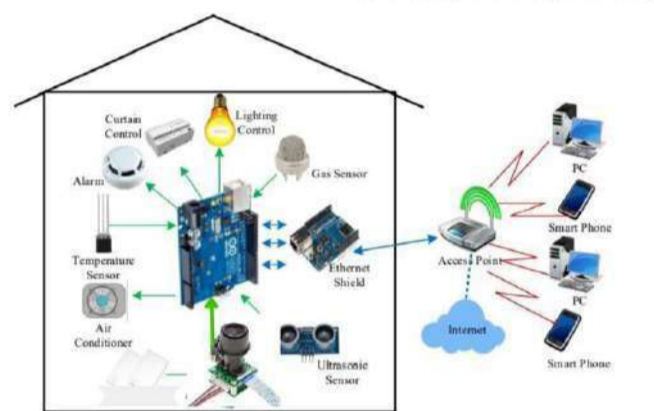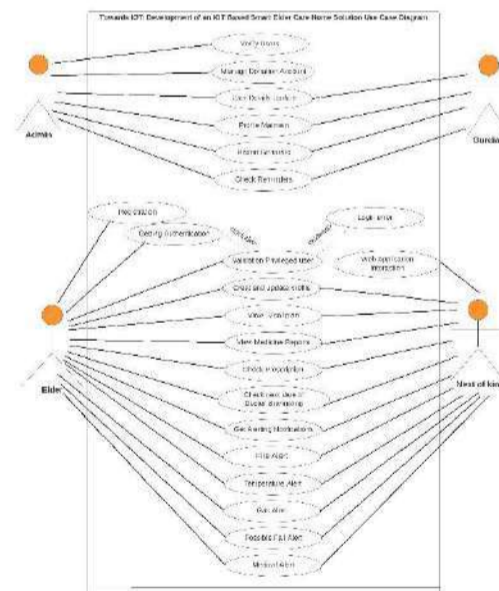

Experimental design where applicable

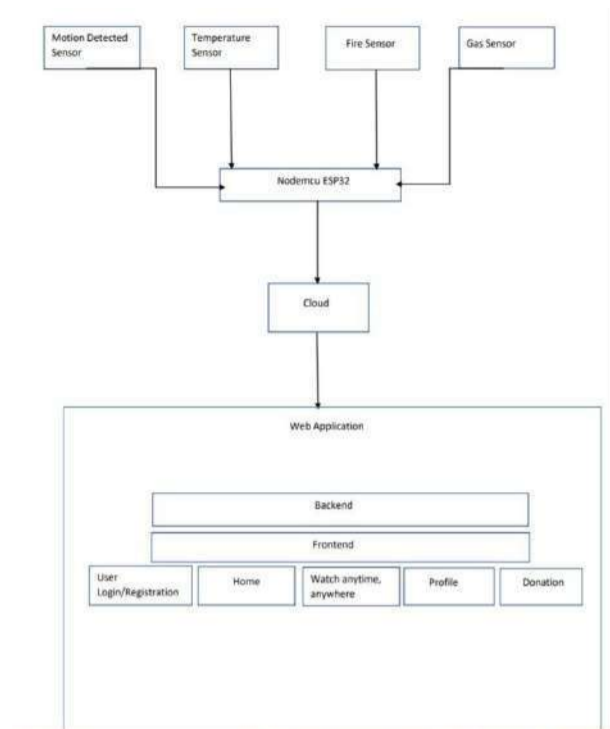Figure 1. Use Case diagram of the system
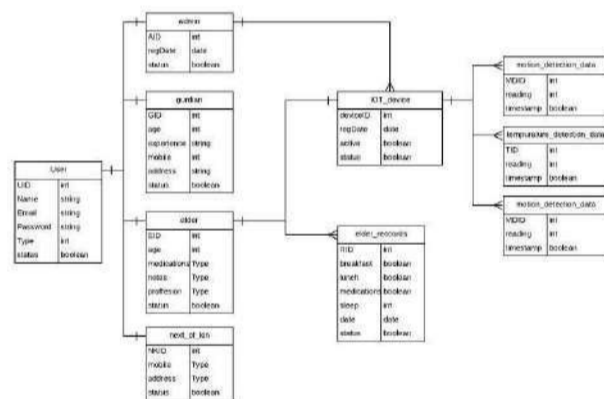
Figure 2. conceptual diagram of the system

what gives the system its benefits and shortcomings. Each system has its own control circuitry for interacting with electrical equipment. To send orders to the control circuits, there must be a unified command system. The system's user interface is the following crucial component. This establishes the user's relationship with the system and the degree of control they have over it. The system's usability is impacted by this.

The major issues that many countries are transitioning to an aging society. Due to physical and mental impairments, the elderly face numerous challenges in their daily lives. Such changes have an impact on two important indicators that represent high quality of life: health and access to adequate medical services. Furthermore, a lack of medical workers, as well as demographic and regional issues, are important impediments to improving medical services. In the face of such obstacles, our elders spend the last part of their lives alone in home or in elder homes. Then they must face various troubles. There are several impacts such as burglary threats, and daily home threats. so, This concept is built for protect or minimize the dangerous situations from elders.

Figure 3. Eldercare Class Diagram of the system

Figure 4. Admin Module

The system proposed uses an Arduino board along with Wi-Fi communication technology It also has the option of another automated mode where there are temperature and gas sensors which can be set to control the appliances depending on the conditions. The system uses an Android smart phone to communicate with a elder home PC those servers as a server. The system connected to and controlled the Arduino board. The mobile phone can communicate with the GSM through SMS alert. Internet access is through Wi-Fi Also depends on Wi-Fi for internet access which is not reliable and not widely available.

This paper compares all of the systems mentioned above. The systems that have been researched have a few characteristics. These systems all rely on the same fundamental communications technology. This underlying technology is

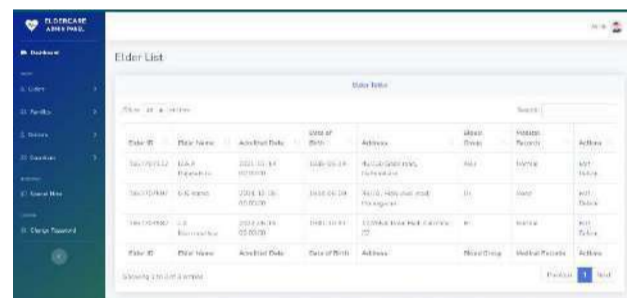Web applications can be developed through several users, such as admin, elder, family, guardian, and doctor. System provides connections to important module the user can use to control the smart elder home. Mostly admin can register elder and select guardian and keep a proper room. on the other hand, if a fire is detected, gas or whatever dangerous situation in the room the SMS will receive by the user.
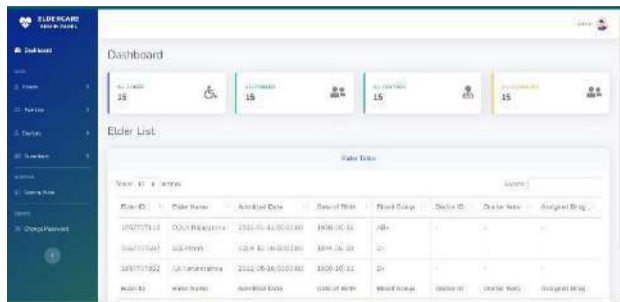
Figure 5. Dashboard

5. Methodology

Providing elder care need input from a variety of sources, which can be aided using digital technology. Both hardware and software are potential technologies that can be integrated into elder care. Some elders spend the last part of their lives alone in home or in elder homes. So that elders face various troubles. There are several impacts such as burglary threats, and daily home threats. sometimes they forget their medicine schedules, diet plans. So, this system built for create the safe zone to elders. By implement this smart elder care home, will solve problem of elder care in society. in the modern world so many people in busy life. so, they can't care their parents or whatever elders in properly. in that situation their parents in alone their homes or elder home centers. This is the huge problem in the world. some time they will die in alone because of unknowing matters. in this system built for avoid their dangerous situations and detect urgent situations. on the other hand, this system provides their food and medicine management. this system can implement in homes and elder homes. as a first level, this system implements to the elder's homes. In here, we suggested to develop and implement an IOT Based Smart Elder Care Home system that can be reduce the doubtful areas and ensure the elder's safety more and more. It will be a web-based application that can connected to the elder's home staff, elders and elder's guardians. With using that system, all the parties that connected to this process will be having quality benefits in an effective way.

This system can remind mealtimes, medicine times and other things that could be reminded to the users. And also, it will detect the unusual situations such as gas leak, fire, and other dangerous situations and make some precautions automatically. This system can implement in homes and elder homes. as a first level, this system implements to the elder's homes.   Technologies:

Arduino IDE
JS
Php
SQL
HTML
CSS
IOT Cloud

The proposed system is more effective for people than the available systems in the industry. There are systems that works like this way but not effective. These Systems are available for online video conferencing and dangerous detection.

People use these kinds of systems but without any innovative developments.

All the functions mentioned above will on this system.

1.Requirement Gathering
- reviewing the available systems
-visit physical centers to gather information
-do some surveys and research about it
2.Design
-UML Diagram
-ER Diagram
-UI Design
-Data flow diagrams
3.Implementation
-Implement the elder monitoring system in the home and surrounded area
-Implement the emergency button and alerting system
-Implement the IOT system

6. Conclusion

It is clear that effective care may allow seniors to live comfortably at home with complete assurance. To do this, a variety of technology approaches may be used, enabling the aged and disabled to get individualized care and quick assistance. The utility of the suggested system has been demonstrated through performance assessment research that looked at a wireless sensor network-based health monitoring system for the aged and disabled. The hardware and software components of the suggested system have both been given in this study. The suggested low-cost technology enables healthcare practitioners to remotely monitor their patients' primary health metrics when linked to the Internet via a gateway. Additionally, it is a useful tool for caregivers of the aged and crippled. Assessment research in a dispersed scenario with a group of senior citizens will be the focus of this project's future work.

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Facilitating the Interaction between medical reps and health professionals through a drug management system

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Abstract: One of the crucial components of healthcare that needs to be managed correctly and efficiently is medication. The drug management system, also known as the drug information system, is a system that stores data and enables functionality that organizes and maintains the medication use process within pharmacies. Some businesses sell medications despite not having pharmacies without a prescription, purchased. It may be found in a pharmacy's standalone building or elsewhere in the same complex. Additionally, there are other places like a pharmacy, a doctor's office, or hospital druggists are licensed. Registered pharmacists are those who have registered with the pharmaceutical council. But since this is a title that is only granted upon the successful completion of rigorously national, practical, and legal studies. this research paper is conducted a survey with the list of 5 questions send to professionals in medical sector to find out the impact of Drug Management Systems (S) in the healthcare industry. Researcher have identified that approximately 81.1% of the respondents of health professionals believe that DMS can provide more accurate, fast diagnosis and reduce the healthcare workers workload. Pharmacists must always be on the lookout for fake prescriptions that addicts who are attempting to obtain narcotics and other prohibited substances unlawfully order. Additionally, the pharmacy indicates that it is engaged in professional pharmacy practice. The appeal of pharmacy is strong. We now can swiftly and effectively acquire or collect huge volumes of information linked to patient care, evaluate it, transfer it, and store it thanks to the availability of computers and the development of information technology.

Keywords: Drug Management, AI, Patientcare

1. Introduction

The management of the database and the pharmaceutical store's administration is the project's main goal. This project examines how a drug management system was created and put into use. By compiling a database of the medications sold in the store, this is accomplished. The drug management system's (DMS) main goal is to boost accuracy while also enhancing the store's security and effectiveness. The creation of software for efficient retail administration is the aim of this project. We have software designed to offer efficient policing through the distribution of statistics in pharmacies. This research already constructed the database, and it will be connected to the program, the relationships, and visual basic.

And also, this research paper aims to study the hypothesis of replacing health professionals with AI in drug management. There are several qualitative and quantitative factors to argue and compare between AI in drug management. The research will be clarified on some important matters on AI technology in drug management such as, what is AI in drug management? what is the purpose of AI? what are the main benefit of AI in drug management? what types of AI involve in drug management? and what are the challenges need to overcome to bring the AI technology? In this paper, outline the state of AI technologies, the potential of such technologies for transforming healthcare, the advance technologies in AI to resolve the problems faced by the healthcare sector, drug management and different structures necessary for healthcare sector.

In this study, six questions will be conducted for health professionals in government and private medical centers.

Objectives:
- Identifying how is artificial intelligence being used in drug management?
- Identifying how drug management system will impact the future of healthcare?
- Identifying the advantages of AI in drug management

A database can be updated using a drug management system, allowing you to keep track of the medications you have on hand. Many pharmacy-related services provided to the drug are managed by this drug management system. A management system called drug management system was created with the goal of improving a pharmacy shop's accuracy, safety, and efficacy. With this program, you can use a database of drugstores for the purpose of conducting the study.

2. Literature Review

a. Potential of Drug Management in Healthcare:
According to "Bhavesh Sharma and Harsh Dubela" the main objective of the project is to manage the administration of the pharmaceutical store and the primary purpose of the pharmacy management system is to increase the accuracy and improve the safety and efficiency of the pharmacy store. The goal of this project is to develop software for the

effective management of the store database (Sharma, Dubela and Bohra, 2021).

According to "A. Jesudoss and M. Jacob Daniel" in existing system there is no proper maintenance for medicine, only LED indication is possible is existing system. There is no sensor in medicine monitoring in existing system. In heath monitoring there is availability of sensor, so I took the concept and applied in medicine monitoring. We propose a new medicine monitoring, surveillance security and SMS alert for medicine management system in the internet of things environment which is used for checking the authenticity of pharmaceutical products and intruders (Jesudoss, Jacob Daniel and Jerom Richard, 2019). Email notification will be appeared for drug management system which is used to check the trusty of drug products and confirm the delivery in my system. The use of the current pharmaceutical management system is essential. It involves information technology, as stated by important from demand to supply, as well as the importance of information about drugs itself both from the point of use and the side effect or consequences of use.

Medicine management is an approach based on evidence to prescribe and manage the patient's medicines to ensure the safety, tolerability, and effectiveness of treatments. With good medicine management, patients experience more satisfactory, safer and suitable care. It helps practitioners to advise the drug for patients in the best way (Chen *et al.*, 2016). The main intention of medicine management is to enhance the efﬁciency of treatments and attain the best consequences for the individual patient.

According to "Ernest" three components of the Medicine Management System (MMS), which are Electronic Health Record (EHR), E-prescription, and Clinical Decision Support System (CDSS) are widely used. Despite the importance of MMS, the adoption rate of information system in Malaysian hospitals are very low where only 15.2% of the hospitals are using the information system, and all those systems are not integrated and have different features (Ernest E et al., 2016). Sell report that is used to confirm the sold drugs to particular receiver. And specially the expiry report confirms the date of expired of drugs, exclude selling of expired drugs to customers. So these reports are used in my system.

According to "K. M. Nasution and Mohd Noah" a pharmacy management system is, especially, to facilitate managing the supply of medicines needed by a hospital, which makes it easier to treat hospital patients in general. This system involves information technology and databases as a repository of information that is useful in managing the hospital, various tools needed to build a reliable system, and this paper discusses those interests' compliance with data enhancements and manual drug supply activities being automated completes this brief review (Nasution et al., 2020). GRN process is used in my

system that confirm the items have been received as expected, in accordance with the original order.

Drug management system is a management system that has been developed with the aim to increase the accuracy and improve the safety and effectiveness of a pharmacy-shop. With this program, you can make use of pharmaceutical stores in a database for the conduct of the study. According to "Kurniawan and Ikhsan" with the rapid development of computer communication technology in click or tap here to enter text. National health reform in China, hospitals have significantly changed their ways in dealing with medical information. Many hospitals introduced hospital information system (HIS) to store, dispose, and manage plenty of medical information by computers, and clinical pharmacy management system (CPMS) is the core part of HIS(Kurniawan and Ikhsan, 2018). Nowadays three components of the Medicine Management System (MMS), which are Electronic Health Record (EHR), e-prescription, and Clinical Decision Support System (CDSS) are widely used. According to "Rabbia Alamdar and Allan Mathews" medicine management is an approach based on evidence to prescribe and manage the patient's medicines to ensure the safety, tolerability, and effectiveness of treatments (Alamdar *et al.*, 2019). The DMS system helps to manage every information about the patients like their personal data, comprehensive medical data, previous medical histories along with their diagnoses, treatments, investigations, and other medical decisions. Apart from that, DMS help in improving the safety, quality as well as one of the most affordable options available in the healthcare industry. According to "A. Jesudoss" the proposed system not only detects inappropriate drugs automatically but also allows users to input such information for any non-prescription medicines that the residents take. Every participant can fully track the residents' latest medicine use online and in real time (Jesudoss, Jacob Daniel and Jerom Richard, 2019).

According to "V. Furdyk" consequently, reforming the healthcare system in Ukraine provides for the implementation of one of its principal directions – the formation of state personnel policy within the healthcare system. One of the essential components of the policy is the development of personnel policy of military medical service, which involves introducing mechanisms for updating the system of its staffing. In this regard, attention is paid to the military medicine management and training system 47 quality of administration in the system of military medicine, which is close to public administration in terms of its methodological basis since it is regulated by statutory acts and the system of orders (Furdyk, 2021). Medicine management system (MMS) came into the picture of hospital management as early as 1960 and have ever since been evolving and synchronizing with the technologies while modernizing healthcare facilities. In today's world, the management of healthcare starts from the hands of the patients through their mobile phones and facilitates the needs of the patient. MMS was introduced to solve the

complications coming from managing all the paper works of every patient associated with the various departments of hospitalization with confidentiality. MMS provides the ability to manage all the paperwork in one place, reducing the work of staff in arranging and analyzing the paperwork of the patient

3. Methodology

This section of the research paper will go through and describe the various research methodologies that were employed, as well as how they were implemented and utilized in a way that helped us answer for our research question. Both qualitative and quantitative research has been conducted as we used both statistics and words to support our findings.

The method of acquiring and finding data to support our findings was to look for academic sources on websites such as Google Scholar and Research Gate, the information acquired was then analyzed to determine if it could be used to back up our conclusions or add value to our research paper. Both primary sources and secondary sources were used in this paper, the secondary sources were the academic research conducted about the topic and the primary source was a survey of 6 questions that surveyed 74 physicians in medical sector and the medical representative in the Sri Lanka, asking them questions about drug management being implemented in their field, as discussed earlier. The questions asked in the survey will be stated along with their answers in further detail in the analysis section. We included both short answer questions and rating questions in survey order to get both qualitative and quantitative research material.

4. Analysis

This research paper conducted a survey with a list of 5 questions sent to physician in medical sector and the medical representative to find out the impact that Drug Management System (DMS) has on the healthcare industry. first began by asking about, what is your profession in medical sector. This was important because this would give us an insight into whether there was a specific department in healthcare that was ahead when it came to adoption of Drug Managment.

For the second question, the majority of the doctor and the medical reps do not have exposure to Artificial Intelligence at all in their workplace currently. To be precise, 39 participants answered in the negative whereas only 17 answered positively. This reasoning is well supported by the survey as most of the respondents that use DMS do not have direct contact with patients and are only used by doctors and medical reps. But the survey also indicates that there is a shift in acceptance of DMS since a few doctor and medical reps, who have a lot of interactions with patients, have also used DMS in their workplace. In the third question, most respondents agree that DMS can give faster and more

accurate responses in healthcare services, and this is unsurprising given how advanced today's computer systems are and how much faster their processing capability is when compared to 10 or even 5 years ago.

In the fourth question, most of the respondents, 81.1% to be precise, agree that DMS would help reduce workload of health professionals. This is because DMS would help take care of the paperwork while they can quickly move from one customer to another.

Question 5 is more specific for the group that is using DMS at work currently; however out of the total 74 correspondents, half of them claim to have a moderate impact on the workplace. Only 27% of the respondents in the survey are using AI in low level respondents from the total number of surveyed professionals.

These are the interpretations that we obtain by analyzing from the survey questions answered by various health professionals working in the healthcare industry in Sri Lanka. The following images are the results of the survey along with the question statements.

Figure 1: Percentage of professional's working
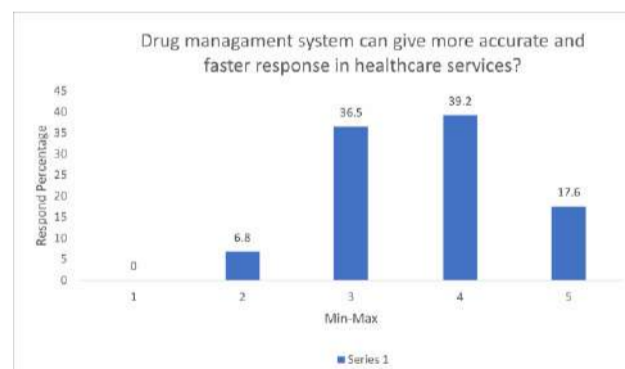
with DMS
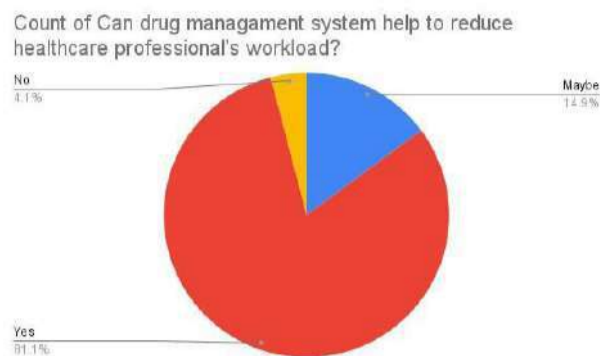

Figure 2: Percentage of response
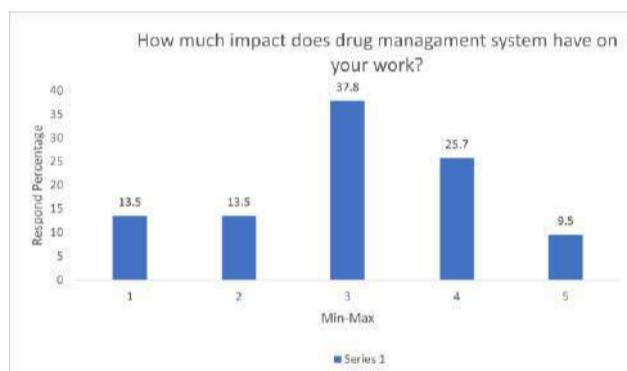
Figure 1: Help of DMS

Figure 2: Percentage of impact

5. Discussion

As discussed in the previous section, among doctors have the highest exposure to DMS. This article further discusses the advances made in recent years in DMS in the medical field. Another article surveyed healthcare professionals including doctors and nurses on the advantages of AI, that included question statements like "AI can speed up the process in healthcare?" and "AI can help reduce the number of errors in DMS?", majority of the respondents agreed with the statement (R Abdullah & B Fakieh, 2020).

The response to a question posed in our survey also produced a result, with approximately 70% of respondents in favor of the statement "DMS can provide more accurate and faster response". according to the same study, A moderate amount of people believe DMS will be able to replace them in their professions, which is in stark contrast to the results of our survey, which indicated that 52.7% of respondents did not believe DMS will be able to replace them at work.

From our finding that, 81.1% of the respondent professionals also believe it will reduce the healthcare workers workload. This is also a very positive step, particularly during a crisis like the Covid 19 outbreak, when

professionals are dealing with higher rates of work overload and burnout. According to the "Raju Vaishya" that DMS has reduced the workload of the healthcare professionals during this Covid 19 pandemic (Raju Vaishya, 2020).

This study also is in line with our finding that DMS will reduce the professional's workload. It encourages more organization and businesses to work on projects to reduce the workload especially during this pandemic. At the same time, 14.9% of the responding health professional's also do not believe that DMS reduced the workload of the healthcare professionals soon. Much previous research has shown that machines will not be able to replace a doctor's or the other health professional's interpersonal skills when handling the drugs. According to the "Jorg Goldhan" this is mainly attributable to the psychological and psychosocial angles involved in a physician patient relationship. AI base DMS will find it difficult to achieve such a level of social skills despite its long-term abilities of deep learning and machine learning skills (Jorg Goldhan, 2018).

Regardless of the fact, that DMS is still in its preliminary stages, some of its consequences include having a favorable impact on clinical scenarios in the healthcare industry. However, the results are not yet fully obvious, and the healthcare industry is only now beginning to feel the impact of DMS at work. Since the growing adoption of electronic medical record systems across many healthcare platforms, AI-based DMS software has been in the development stages. IBM Watson, Google, and other multinational software giants have been in the forefront of developing such platforms.

Despite the welcoming attitude, professionals in healthcare widely recognize the fact that DMS is not flexible enough to suit the needs and demands of every patient which they encounter in daily practice. This should be taken with more importance due to the bias in our research due to the increased correspondence from doctors and medical reps combined and effectively using DMS their workplace. Hence this bias emphasizes this point of research.

6. Limitations

There are a few limitations to this study that should be noted. One limitation is that our sample size 74 people is small, making it difficult to assess statistical significance in replies and differences between them, particularly amongst occupations. The sample size was kept small to encourage people to take the survey and prevent muddying the results. Second, there is the issue of selection bias since some respondents may have simply been curious about DMS and thus responded positively their preconceived conceptions about DMS. Finally, rather than being from a specific specialty, our survey participants were from a variety of them. A few studies in the past have focused solely on

medical reps and doctor professionals because this field is the most advanced in DMS adoption.

7. Advantages

1. The online drug management software system is a terrific way to manage pharmacy operations as it does not make bills for expired products. This software alerts the staff at the counter about the expired medicines and helps the store owner to systematically purchase latest items.

2. The expiry dates of products get displayed when the billing is done for different batches of the same product. The right batch of the item is chosen based on the FIFO (First In, First Out) and LIFO (Last In, First Out) policy.

3. The store owner or pharmacist can maintain a separate register that has details of all the drugs stored in the store with the help of the pharmacy folder. This is an excellent feature as it keeps track of the composition of medicines and provides substitutes of the medicine that is not available for sale. This is a life-saving alternative in case of emergencies.

4. With the help of DMS, store owner and pharmacists can monitor the patient's treatment as per defined safety standards. Pharmacists can also access and review the sales history of drugs.

5. Customer relationship management module of the DMS software stores all details about the customer. The DMS software helps owners send emails and SMS alerts to customers about lucrative offers and promotional schemes. This wins a customer's trust and increases the owner's customer base.

6. The pharma distribution software has an interesting feature of automatically assigning orders to various distribution channels depending on thesupply date of the items and the number of days needed to deliver the order to the customers.

7. Pharmacies interact with several customers every day. The data they collect is stored within the drug managment system. Also, the data can be used later for enhancing the business strategy.

8. The software should know how to deal with data to keep information about related items. Adding and storing the details is a huge task and requires automated assistance and not human assistance.

Also, at the end of the month, there is a need to calculate the revenue generated.

9. The admin can maintain a separate folder that includes the details of medicines and drugs stored with the help of the drug information folder. It is a notable feature that keeps you updated about the composition of medicine and substitutes.

10. Particularly for people who are uncomfortable speaking with doctors and pharmacists in person, this approach offers significant convenience. Additionally, ordering drugs is possible without any restrictions on particular matters like sexuality or adolescence that can be embarrassing.

8. Conclusion

In this research paper researcher reached some conclusions and findings. Healthcare DMS in Sri Lanka primarily spread in the specialization of pharmacy.

According to results of the survey:

- 52.7% professionals in the Sri Lanka are not using DMS in their workplace.

- 75% of professionals in the Sri Lanka believe that DMS in the healthcare industry gives a faster and more accurate response in services.

- 81.1% professionals in the Sri Lanka think that DMS would help in reducing the workload on doctors and medical reps.

- Out of the total 74 correspondents, half of them admit that DMS would impact their work.

Researchers can attest to the fact that drug managements well-received by Sri Lankan health practitioners. It's importance and assistance in the healthcare industry has convinced health experts; yet it cannot replace their valuable presence and responsibilities. In other words, doctors, medical reps and other health profession can use DMS to assist them rather than replace them during drug identifying, inspections, and management.

DMS is employed in a variety of medical fields, including maintaining healthcare records and data and drug development, among others. It can also assist physicians in accurately analyzing and treating patients. even when DMS is used effectively, it has some disadvantages, such as cost savings due to increasing machine development, and it also influences human interference, which poses a huge challenge in the workplace.

Every invention will have both advantages and disadvantages, but we must evaluate the good aspects to further the world's progress. DMS has a major impact on the healthcare industry's growth. In order to give more accurate

clinical decisions and enhanced drug management efficiency, DMS requires a huge amount of healthcare data to train and learn from. Drug management techniques of many types are used to

evaluate structured and unstructured data from healthcare data warehouses. These procedures enable a customer to receive a more accurate and efficient management, and the faster and more accurate the servicers.

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Acknowledgment

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Bin- Eazy: The tracking-based solid waste collection system

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Abstract: *The majority of developing countries, including Sri Lanka, still we are struggling to manage solid waste, resulting in a slew of social, environmental, and health issues. In Sri Lanka, as in the majority of other nations, the responsibility for waste management is delegated to Local Authorities (LAs). With rising solid waste quantities, Sri Lanka is now struggling to manage trash. This research, this study aims to develop an Automated solid waste management collection Mobile application name as "Bin- Eazy" and a Web application to reduce the above situation in Sri Lanka. These applications facilitate both the Municipal Council and the citizens to avoid the problems that arise during waste collection. This methodology for the improvement of the waste collecting and transportation system was devised based on Google Map API. This system includes a mobile application to organize garbage in various locations. We can communicate directly with the Municipal Council and provide information on the location of the garbage bins or dump with this mobile application. Python, Image Processing, Flutter, SQLite, and React are technologies that were used in this project. Image processing is the technical analysis of images using complex algorithms. The municipality uses image processing to check whether the citizens have correctly classified the garbage. This system mainly focuses on household solid waste. In a country like Sri Lanka, both residents and municipal councils may save time and money by using this mobile application to collect solid waste. Those are the expected primary goal of this paper.*

Keywords: *Solid waste disposal, Location tracking, Image Processing*

1. Introduction

In today's world, the waste collection has become a serious issue. Garbage has become one of the primary problems in a country like Sri Lanka as the population grows. There are no suitable facilities for the final disposal of waste produced by households and industries in a country like Sri Lanka. Furthermore, relevant authorities pay less attention to the situation. As a result, people used to dump garbage alongside the roads. In countries like Sri Lanka, daily life can generate many kilograms of solid trash from homes, industries, businesses, and other locations. The lack of proper management has led to many problems. In Sri Lanka, this garbage collection is usually done under the control of the Municipal Council.

Table 1. Municipal waste generation in Sri Lanka

Municipal Councils		Population (2001)	Daily waste generation (Tons)
1	Colombo	642,163	675
2	Dehiwala	209,787	272
3	Moratuwa	177,190	150
4	Kotte	115,826	125
5	Negombo	121,933	110
6	Galle	90,934	50
7	Gampaha	9,438	20
8	Kandy	110,049	80
9	Matale	36,352	26
10	NuwaraEliya	25,049	20
11	Badulla	40,920	20
12	Jaffna	78,781	NA
13	Rathnapura	46,309	30
14	Kalmunei	105,000	50
15	Kurunegala	38,337	38
16	Kaduwela	270,000	35
17	Dambulla	66,727	67
18	Batticaloa	88,459	60
19	Anuradapura	81,522	37

Source: (Amarananda, A.G. 2006)

For residents living within the municipal area, garbage should be kept outside on the day relevant to them. But in this process, the municipal council, as well as the citizens, face various problems. And as Sri Lanka develops, more people are moving to cities for their benefit, due to the increase in garbage production. As a result of these factors, the garbage problem has become a major issue for the wider populace. Various waste collection and management methods can be found all over the world. However, no proper computer-based waste collection system has yet been built in Sri Lanka.

A. Objectives

This project aimed to develop an Automated solid waste Collection & Management System as a solution to the disposal of garbage in Sri Lanka. This system will create a web application and mobile application. we named our mobile application as "Bin -Eazy". It is supporting the both Sinhala & English languages.

The following objectives have been identified with the aim of growing an Automated Solid Waste Collection and Management System.

- To Conduct a critical examination of Sri Lanka's current garbage collecting difficulties.
- To Analyze the current computer-based systems critically a waste collection solution.
- To make a project prototype of the system.

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- To Determine the effectiveness of the new Automated Solid Waste Collection and Management System.

B. *Resource Requirements*

- The development of the mobile application is assured by its compatibility with all other mobile devices running Android, iOS, and Windows.
- The database will be implemented by using DB forge studio for SQLite.
- The web server will be created such that it works with all Windows 7, Windows 8.1, and Windows 10 computers.
- Android Studio and Dart will be used to implement the mobile application.
- The DJango framework and the Python programming language will be used to create the administrative interface.

2. Literature Review

The amount of waste produced increases as the population grows. The more people a city has, the more complicated its activities and companies become. Industrial, biological, and domestic garbage are all dealt with via waste management. Waste can, in some situations, be harmful to human health. Waste management is also carried out for the purpose of gaining advantages, particularly for people. Based on the belief that rubbish is a resource that may be utilized and even has financial value (Hidayati, A., *et al. 2019*).

A healthy and happy community requires a healthy environment. The process has been prone to human mistakes and neglect with the age-old system of hiring employees to periodically check and clear overflowing dustbins. Furthermore, due to the varying rates of trashcan usage in different places, routine checks based on time crevices are wasteful because a dustbin may fill early and require rapid attention, or there may be no need for a routine check for a long time. As a result, the current system becomes more of a problem than a solution, as overflowing, smelly trash cans become an issue rather than a solution (Jetendra J, *et al*, 2016).

A. *Existing system*

According to the research done by R. Zade et.al, they had This study introduces a novel system that will aid in keeping cities clean. This system monitors the garbage bins and notifies users via a web page on the amount of waste collected in the bins, as well as alerting users via a buzzer and LEDs. The ultrasonic sensors (HC-SR04) in the system are utilized to detect the rubbish level over the bins. The depth of the waste bins is then compared. The system's hardware architecture includes an Arduino module, an LCD, a sensor, and a buzzer. On the LCD panel, the level of rubbish collected in the bins is indicated. The system is remotely monitored via a web page created in LabVIEW using the VISA tool. When the amount of garbage collected exceeds the stated limit, the buzzer indicator goes off. As a result, by informing the public about the rubbish levels in the bins, this system contributes to keeping the city clean (R. Zade *et.al*, 2018).

It handles with actual time trash bin observing scheme by participating various identifying equipment and new technologies to the research paper of "GARBAGE MONITORING AND CLEARANCE USING ROBOTS" studied garbage disposal that isn't done properly pollutes the atmosphere, endangering living organisms. Recent technological advancements are proving to be more beneficial to humans, and their recommended approach for waste collection is excellent. An ultrasonic sensor attached to the bin lid shares the garbage level as data to the robot, which tracks the bin using the line follower technique and recognizes the filled bin using RFID scanning, then disposes of the rubbish from that bin. When an Ultrasonic sensor provides data to the Arduino board, the garbage monitoring and clearance robots begin their work. The exposed ultrasonic sensor is a form of audio sensor that can be categorized as the transmitter, transceiver, or receiver. Ultrasonic sensors have transmitters that turn signals into ultrasound, and receivers that translate ultrasound into signals. The period between delivering an ultrasonic pulse and receiving an echo. The sensor sends out a wave, which is reflected by the obstructions. It detects the amount of rubbish and sends the data to the Arduino Uno (Raja, P., Janani, C., & Thivya, A., 2020).

This paper describes they frequently bring up the concept of a GSM-based garbage monitoring system. People are disposing of their junk in the trash container. At the top of the garbage can, they are installing ultrasonic sensors. Currently, the ultrasonic sensor can detect the level of garbage. If the amount of rubbish produced continues to rise, it will soon hit the limit. As soon as the threshold value is met, an automatic alarm will be sent to the registered range via the GSM module, informing them that the trash value has reached a distance of around 5cm from the ultrasonic sensor. The garbage cans are emptied, and the data is forwarded to the appropriate authority for processing. For real-time information, they used GSM. It is the most important component of the communication system because of its low cost, high performance, and ease of implementation. Even if the threshold value crosses the range, the LED will illuminate if somebody tries to dump their trash in the garbage can. This strategy reduces the amount of time, fuel, and money used. In the future, this technology will be beneficial to a large number of rural areas (Kadarkarai, P*., et al*.2021).

According to the research paper, "Smart Garbage System with Garbage Separation Using Object Detection" studied garbage collection is one of the most pressing concerns that the globe faces, regardless of whether a country is developed or developing. The traditional method of manually monitoring and clearing rubbish in bins is inefficient. As a solution to these issues, the smart bin is developed utilizing IoT. The bins have a Raspberry Pi fitted with an ultrasonic sensor for garbage level detection and a pi camera that uses the YOLO algorithm to segregate rubbish by object detection and opens the appropriate bin lid using a servo motor. The intelligent bin is linked to

mobile applications through the cloud for garbage monitoring and disposal, which is accomplished through optimum routing (D. Vinodha, *et al*, 2020).

In 2020, "Deep Learning-Based Smart Garbage Monitoring System" an IoT-based, automated smart bin monitoring system is proposed in this research. Furthermore, based on the data acquired, a deep learning model was utilized to anticipate future garbage levels. With an accuracy of 80.33 percent, the suggested neural network model was able to forecast garbage levels. The findings support the accuracy of the rubbish level forecast. Bar charts were also used to assess the data. The combination of IoT and deep learning can result in a technological revolution that can be used for trash management. As a result, forecasting and examining garbage levels may assist municipal authorities in implementing an efficient garbage management system and reducing garbage bin overflow (Pratyaksh P., *et al*, 2020).

B. Related works in Sri Lanka

Over the past 20 years or so, or thereabouts, government entities have been working to identify the ideal waste management strategy in the country. Although certain tactics and initiatives promoted clean landfills, other actions were focused on energy programs against waste. With the goal of "Squander Free Sri Lanka by 2018," CEA launched the "Pilisaru Project," a 10-year waste management framework, in 2008. Unfortunately, the lack of a sensible, long-lasting approach has increased the amount of opaque and pointless processes (Dassanayake,2019).

The distance between waste producers and recyclers should be closed by igniting more variety communities and making the cycle more readily available. Plastic, polythene, metal, and glass recycling activities should be stimulated and funded at diverse scales. As was discussed, he conducted research. Waste is a resource; hence efficient waste management practices should be implemented. The industry should be set up as a business that generates revenue rather than one that offers no incentives to the corporation (Cialani, C., & Mortazavi, R., 2020).

3. Methodology
A. Data collection

Sri Lanka, being a developing country, is currently experiencing fast population growth, infrastructure development, and urbanization. The first step in data collection to create this system was to identify the objectives through a literature review. To identify the existing problems, interviews were held with the municipal employees and citizens who are the primary users, and information was obtained. had comprehensive experimental case study was carried out with Moratuwa municipal council to obtain information. 40 truck drivers and garbage collectors belonging to the municipality were selected as the sample. And 50 citizens belonging to different age groups were randomly interviewed in some selected cities. According to the data obtained, the

percentage of citizens who are not satisfied with the existing waste collection system is 68.2%. About 9% of the respondents are satisfied with the current system.
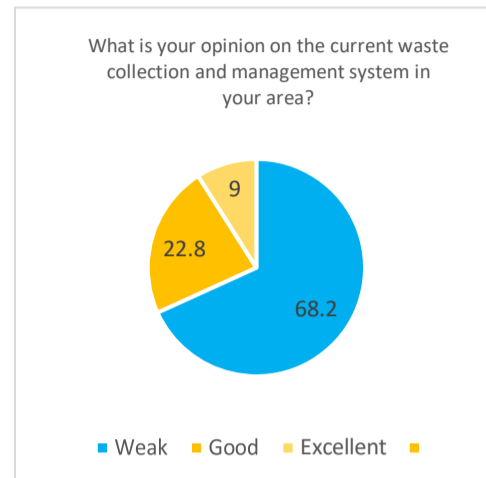

Figure 1. Pie chart I of Questionnaire Survey Results

percentage of 61.8% of the truck drivers said that problems arise due to the non-sorting of garbage.
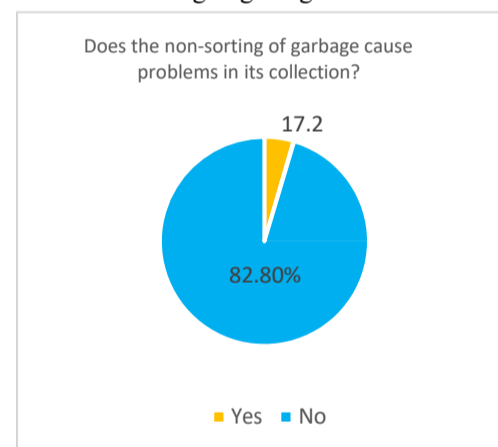
Figure 2. Pie chart II of Questionnaire Survey Results

According to the information obtained from the Moratuwa Municipal Council, the garbage of about 700 houses should be collected by one truck per day, but due to unnecessary time and effort, it has become impossible to do this. The primary purpose of this data collection was to obtain the data needed to create these proposed systems through problem identification and analysis. Key issues identified through this data collection are outlined below.

The problem faced by Citizens

- The resident is unable to dispose of garbage on the scheduled day, he will have to wait until the next day.
- In some areas, the interval between dates maybe four or three days. If it is decaying debris like disposable foods, they will decompose, breeding worms and rodents around it, causing odors and polluting the environment.

- The public can have a lot of problems disposing of non-biodegradable waste and they are many problems with waste sorting as well as recycling.

A problem faced by Truck drivers

- The main problem here is that even though they have been given the proper roads, they have to park the truck near every road and every house to see if there is any garbage. This consumes their time as well as labor.

- Householders do not properly sort garbage and face problems in garbage collection.

- Similarly, worms and rodents can breed in decaying materials such as disposable foods, which have been deteriorating for days, and they may be exposed to various diseases while doing so.

3. *Technology Adopted*

Using acceptable tools is essential to developing a defect-minimized productive system. Failure to do so may result in the development of a system with unnecessary bugs and errors using inappropriate tools. Therefore, it is essential to choose the right tools while creating a system so that a superior product can be developed. However, these technologies could lead to the creation of a system that requires a lot of time and resources to complete a task that the system had expected. The usage of application programming languages and the other required tools is crucial for the development of a successful system. As a result, these technologies and tools can contribute to the system's development in the least amount of time. Instead of using a manual approach, this type of application seeks to provide users with a more effective work system. This research purpose is to develop an Automated solid waste management collection "Bin-eazy" Mobile application and Web application. This mobile application has two types of users: citizens and Municipal council Truck drivers. This mobile application supports the following technologies:

2. *Google Map API:*

Google provides technology and an application called Google Maps for its online mapping platform. The Google Maps API enables you to produce customized maps that can be used in cutting-edge Google Maps-based apps. In all Maps API applications, the maps are loaded using an API key. The API key is free, but Google will monitor your application's use of the Maps API and, if it reaches the use cap, require you to purchase more capacity. (Smita S*, et al*, 2019) Here, Google Maps is mainly used to help truck drivers find the optimal route to collect waste. Truck drivers are shown only the request to collect garbage bins and garbage dump through Google Maps, so they can reach them using the best short path in a very short time. fuel, money, and time can be saved by these methods. The

second major step here is that citizens can also use Google Maps to find the garbage truck.

3. *Flutter:*

Although highly unique, Flutter is also maybe a viable platform that has already gained the interest of major firms that have already published their apps. However, since Flutter implements components, there is no layer of interfacing between the view and the code. Because of this, the graphics engine of Flutter is used to draw buttons, text, media elements, and context. Flutter is used to create The Mobile application front development.

This Web application has one user: The municipal council administrator. This web application supports the following technologies:

4. *Image Processing:*

The technical analysis of images using sophisticated algorithms is known as image processing. Image enhancement, pattern detection, and effective picture coding are three major areas where image processing techniques are used. The mathematical operations that one is likely to run into and how to execute them using optics and digital computers, as well as image description and image quality assessment, are some of the areas of image processing that are covered. The system checks whether the photos uploaded to the system by the citizens through the mobile application have been correctly classified using an algorithm trained by image processing.

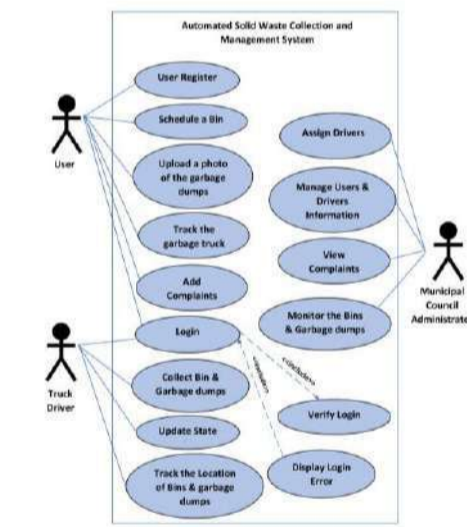**4. Experimental Design**

Figure 3. A use case diagram for experimental system design

A. Mobile application

Mobile application users the Truck drivers and citizens. In the Waste collection system process first, the citizens and truck drivers (Users) should create a profile. Next, they should log in to the Mobile application by providing the user's name and phone number to the system. Citizens and

truck drivers have a separate interface after the authentication process.

Figure 4. User register interface   Figure 5. User login interface

As in figure 6 below users can then use the mobile application to request that their trash be picked up. And also, citizens should take photos of the requested garbage dumps and upload them to the system to see if they have correctly sorted the bins. After they get the approval of the request then they can track the Garbage truck location.
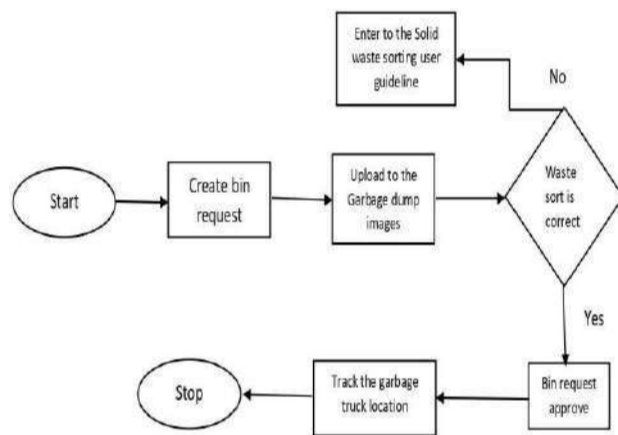

Figure 6. Process flow diagram for citizens bin request process

Truck drivers are shown only the request to collect garbage bins and garbage dump and their locations through Google Maps through the mobile application. After tracking the bins' locations, they will be shown the shortest route through google Maps. Garbage collectors should report bins' status to the system after collecting them. This Mobile Application provides the both Sinhala and English languages.
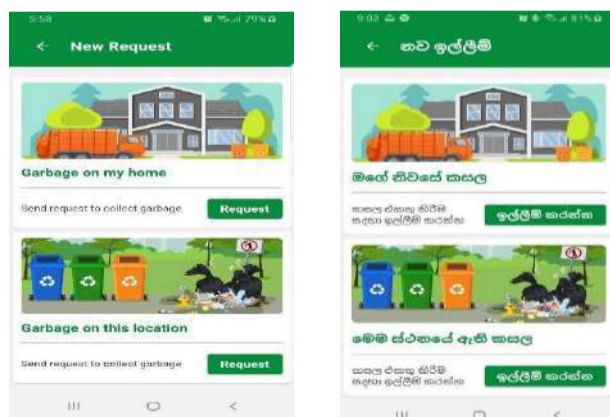

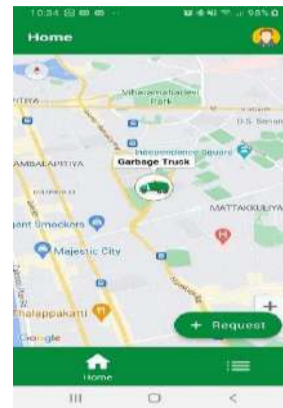Figure 7. Request interface for citizens (English & Sinhala)

Figure 8. Garbage truck location interface for citizens

B. Web application

Only the municipal council administrator can be accessed using the web application. The details from the mobile application will be presented on the municipal council's web server after they have been extracted. The mobile application will then track the coordinates (longitude and latitude) of the user's location (where the garbage dump is located). The information, including the user's identity, mobile phone number, date and time, and coordinates of the tracked waste dump, is then sent to the Municipal Council's web server. Using image processing, the image uploaded by the users is checked to whether it is correctly sorted under the given instructions and then their request is approved. According to the coordinates received by the mobile application, the location of the waste will be displayed on a map. The appointed employees will then be dispatched to that specific location to collect the waste. Then through the system municipal council administer can track their location and assign a driver collect to the waste the web application will send a notification to the user whether the information sends successfully or not. Each information that users send will store in the SQLite server database successfully and for work with the application.
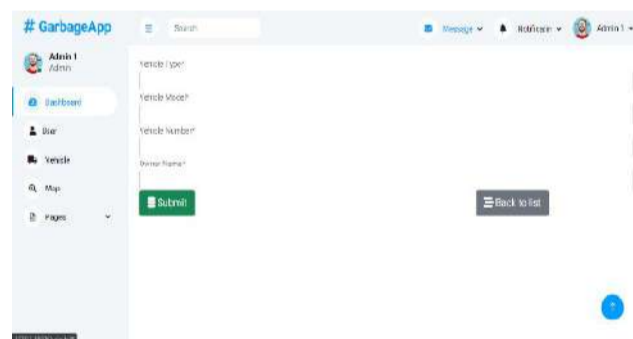
Figure 9. Driver assigns Interface of the web application

5. Discussion & Conclusion

Based on logical presumptions, the results and consequences produced concerning the problem domain's specificity are expanded into broader notions. This chapter attempts to highlight the project's outcomes and findings and to identify how they might be matched in other situations that share issues with those that the developed solid waste collecting and tracking system addresses. To

obtain a comprehensive waste collection system to meet efficiency and optimization, this test work requires that the proposed system only knows the exact location of the waste and collects them. When citizens request through the mobile app to pick up their garbage, the system administrator in the municipality directs the relevant truck drivers to those locations and collects the garbage. Similarly, by using modern tools i.e., using image processing, the classification of them into biodegradable and non-biodegradable materials is done through this system. Then it becomes easier for the garbage collectors. Our project's primary goal is to make it possible for city infrastructure put there to communicate with its operators and administrators in both directions. Our objective is to realize a centralized system for real-time monitoring. With this approach, the municipal government and the general public both gain from an efficient system that reduces urban pollution and results in significant cost savings. The research outcome can be stated as follows. Saving time for the Municipal council's laborers and administrators who work on solid waste disposal.

- Reduce the time consumption of the collection of household solid waste.
- Reduce human errors.
- Make the workload of the municipal council more efficient.
- Reduce the workload of the municipal truck drivers.
- Increase the efficiency of service in Municipal councils.
- Improve the solid waste management program in Sri Lanka.

6.   Future Work

There isn't a system in place with a mobile application to address the current problems that have been affecting the Waste Collection process on the overall Traditional Waste Collection strategy, especially in Sri Lanka, even though there are numerous different waste management and waste collection systematic approaches. As well as waste management and related research have already been done in many projects. Therefore, this proposed tracking-based solid waste collection system is presented. With more effective usage of the app and improvement of additional crucial hardware components for future development, the Google map API advanced feature activation can be included as a further improvement. The information on the efficiency of a systematic solution may have been gathered to conclude this research study area by reviewing related works and existing systems, and its evaluation summary provided the points to be taken into account in creating such a real-world application in the future with the digital era and to survive with challenges like pandemic situations and the current new normal.

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Review for an Information Management System for Automation the Covid-19 Vaccination Programme in Sri Lanka

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Abstract: *The COVID-19 epidemic has swept the globe. Early in 2020, the epidemic began in Sri Lanka, and it is presently in control of the Indian Ocean's pearl. Vaccines that have been created all around the world are currently being used in Sri Lanka as well. To prevent many individuals from congregating in one location, the vaccination procedure is carried out in batches on several days. The divisional secretariat offices of Sri Lanka maintain the information of the immunized using a manual, paper-based information management system. The whole procedure, from the collecting of forms to the tally of the total number immunized, is carried out manually. Through the conversion of the manual paper-based information management system to an automated information management system, this research intends to identify the challenges that this manual paper-based system faces and how to fix them. This study is predominantly designed as positivism paradigm based on survey data. Further, the findings of the study draw conclusions on the issues with the present system and the features and functions that ought to be added to the automated COVID-19 vaccine information management system using published research papers, scholarly articles, web articles, questionnaires, and interviews. The result of the study indicates that the manual system is not viable to carry on the task and it should be converted to an automated system.*

Keywords: *COVID-19 Vaccination Information Management, Manual Information Management Systems, Automated Information Management Systems*

1. Introduction

The World Health Organization issued a public health emergency over the COVID-19 virus on January 30, 2020. Over time, the virus evolved into a pandemic and is currently spreading around the world. The first COVID case in Sri Lanka was recorded on March 11 of this year, and as of now, there have been 486,000 cases and 11,296 fatalities. There are several vaccinations that have been produced to combat this hazard. In Sri Lanka, several of these vaccines have been used, including Moderna, Sputnik V, Sinopharm, Pfizer, and Covid Shield.

The maintenance of vaccination records in the pertinent divisions of Sri Lanka is under the control of the Divisional Secretariat Offices. A manual paper-based information management system is used to manage the data. The folks who are about to receive a vaccine must fill out a form and provide it to the staff at the vaccination site. The divisional secretariat of the region receives the forms when they are collected. These forms, which are delivered in boxes, are laid out in the sun to dry for two days, after which the authorities physically inspect and tally the information.

This research is intended to solve the issue that the manual vaccination information management system has several deadly defects. The boxes containing the forms are spread out to dry in the sun as the first stage in the procedure. This is done as a precaution to get rid of any bacteria that could be on the forms. In comparison to the forms at the bottom of the box, those at the top of the box receive good sunshine. The information contained in a form is permanently lost if it is impressed by the wind. After the drying process is finished, the authorities personally collect each form and compare the information to the electoral role list to ensure that the information is correct. Finally, a hand count of the totals is performed. The total productivity and efficacy of this system are quite poor.

The main emphasis of this study is on how to create an automated information management system to handle COVID-19 immunization data in order to address the challenges that the current manual paper-based COVID-19 information management system faces.

Due to how sophisticated technology is now, automation is one of the most highly appreciated parts of the information management process. Automation outperforms manual systems in terms of production and efficiency by a wide margin. Due to how sophisticated technology is now, automation is one of the most highly appreciated parts of the information management process. Automation outperforms manual systems in terms of production and efficiency by a wide margin.

2. Literature Review

All researchers working to automate manual-based processes and improve existing information management systems can greatly benefit from the findings of this study. In other countries, there are several automated information management systems, some vaccine management systems,

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and very few COVID-19 vaccine information management systems, however Sri Lanka currently has none of them. Only an online gateway is available for those aged 20 to 29 to register for the immunization. The COVID-19 vaccine is presently the most crucial component. not only in Sri Lanka, but everywhere else in the world. The whole world is uniting to combat this epidemic. The management of colleges and universities has entered the information management era as a result of the quick growth of contemporary computer network technology. For many academics, improving the information quality of the student status file management system using contemporary network and database technology has been a hot subject. Every university must maintain its student status information archives, and each institution places a high value on the information contained in these archives. As a result, it's important to create a management system for student status archives that can give university officials access to correct information and efficient search tools. The manual administration of Student Status Archives in the past can be made simpler by this approach. (ZHANG, 2019)

The following is from an information management system designed to manage the data of students, "The man-machine interface is friendly, the operation is simple, and has good stability, security and expansibility. Make the university student information management work more standardized, functional management personnel, counselors, students and other different role information exchange ability, and in the whole school to achieve the sharing of information resources to achieve a variety of student information data, making the university students management work more efficient, reasonable and orderly." (Hu, 2016)

A particular number of doses of a vaccine are required for an individual and are given over a range of times. Therefore, it is important to maintain the individual's data well, especially the precise data that indicates the number of dosages taken.

A key role in the management of information is the management of data as a resource. The quality and applicability of the data supplied determine the value of the information. Because computerized database management systems (DBMS) make it possible to handle data quickly and easily, the conventional technique of keeping files by hand and on paper is ineffective. (Martiz, 2003) There are many steps in the administration of COVID-19 immunization data. Application for the vaccination, transmission of the application to the relevant authorities, receipt of the data by the authorities, validation of the data through comparison with a document containing precise information, updating of the individual's vaccination status and doses, total number of people in the area who have received vaccinations, and the next scheduled vaccination date for that group.

A fundamental function of an information management system is the collecting and administration of data kept in various forms while enabling simple retrieval for those who need it. An information management system centralizes data, preventing duplication in several locations or in multiple forms. This feature stops unrelated individuals from accessing the information.(Weedmark, 2019) A management information system gathers and processes data (information) and makes it available to managers at all levels for use in decision-making, planning, program implementation, and control. The divisional secretariat can be viewed as the managers of this vaccination information management process. The MIS has a variety of tasks to complete, including the functions of decision support, performance monitoring, and functional support. (Nayak, 2007) A computerized record-keeping system is known as a database management system. It serves as a collecting point or container for computerized data files. The general goal of DBMS is to give users the ability to define, save, retrieve, and change the data in the database as needed. Anything that is important to a person, or an organization might be considered information. (Kahl, 2015)

For ease of access between the divisional secretariat, the MOH, and the vaccination clinics, the information management system for the COVID-19 vaccine should be a web-based information management system. The foundation of every business process integration is its information systems, whose main objective is to support decision-makers by providing accurate and timely data that enables them to make the best decisions possible in a chaotic environment.(Hakimpoor and Khairabadi, 2018) The new Web-based system exhibits considerable performance improvement in production rate and accuracy while reducing coding cost with a greater speed. Additionally, it makes practical usage easier by providing a simple Web user interface.(Jung *et al.*, 2008)

The following is a sample instance of where a web-based information management solved a conundrum of applying for leave manually. Though the circumstances differ the concept behind it which is saving time,reducing fatigue and automating the processes are more or less similar to the conundrum being addressed in this study.

The time-consuming manual process of requesting leave has been replaced with the Web-based Leave Management System. It makes it easier for employees to submit a leave request online and receive higher-ups' approval. Additionally, the system's automation helps shorten the time it takes to submit requests and do away with paper work. The Web-based Leave Management System is now a great resource for employees to apply for leaves, check

on their status, and produce leave reports. It also makes it easy for administrators to fill up staff profiles, establish leave kinds, create departments, and fill out leave reports. When a person applies for leave or updates their leave status, the system notifies higher authorities.(Ramanan, 2021)

Additionally, the system should be web-based to avoid negative effects like duplication of operations across all units, duplication of database entries, higher expenses for maintaining and protecting the database, and increased costs for maintaining and managing each unit. This demonstrates how crucial it is to have an interoperable system that enables management of all units from a single place.(Oluwatofunmi, S. and A., 2018) Additionally, a web-based information management system is equipped to manage enormous volumes of data from a single place. A collection of Web pages is not the same as a web-based information system. Workflow is facilitated by the latter, which is frequently closely linked to non-WIS systems like databases and transaction processing systems.(Bieber and Vitali, 1998)

Man can influence his surroundings by manipulating matter and energy through information handling systems. Information is produced as a result of the detection and identification of events in that particular environment. After then, this data is sent, analyzed, and displayed. Decisions that will produce the desired outcome are made possible by these three functions.(Vazsonyi, 1995)

In terms of contemporary technology and society, automation is regarded as one of the most valuable things. The highest productivity in automation is regarded as an extremely high valued achievement. The external needs and changes occurring around the operation are the straightforward mechanism for automation. factors that are internal, with strong organizational and human resource connections to the previously listed component. a system with clearly defined flexibility and human interaction as a tool for utilization, both of which are viewed as flexible and cognitive resources.(Mishev, 2006)

3. Methodology

This study's goal is to automate the divisional secretariat offices in Sri Lanka's manual, paper-based COVID-19 vaccination information management system. The purpose of the study was to pinpoint the current issues with the manual method that is in use. The divisional secretariat offices in Sri Lanka are the subject of the research. The responders to the study are the staff members of the divisional secretariat offices.

A. Collection of Sample
The population of this research were the officials of the divisional secretariat offices in Sri Lanka. For the ease of gathering data samples were taken from the divisional secretariat offices of Wattegama.

B. Collection of Data
The The tools used for the collection of the data required for this research were questionnaire and interview and published research journals and scholarly web articles on automation of information management systems, automation, and conversion from manual paper-based information management systems to automated information management systems. The questionnaires were distributed online, and interviews were conducted to further enforce this study.

From conducting this research, the following factors surfaced. The divisional secretariat is in charge of managing the information of those who have been vaccinated against COVID-19 and their manual paper-based system is struggling in aspects like proper securing of data, the validation of the data, the input of the data into the system, the efficient management of data and the calculation of the data records.

The preliminary step taken in this research is the identification of the focus of this research which is the improvement of the manual paper-based COVID-19 information management system through automation and the features required for the automated information management system. The secondary step was the recognition of the required content through the perusing of published research journals and scholarly web articles. The tertiary step was the preparation of questionnaires and the conduction of interviews with the related parties. Next came the analyzing and categorizing of the functions and features required for the automated COVID-19 vaccine information management system. Finally, the results of the analysis were interpreted, and the results of the research are presented.

C. The Development of The System
The development of the system will do using the Rapid Application Development methodology. The system will be developed using the Laravel web framework and PHP MySQL will used for the database.

4. Analysis
The current COVID-19 vaccine information management system, which is manual and paper-based, is in trouble. This study recommends a computer-based automated COVID-19 vaccination information management system as a remedy for the problems the present system is currently experiencing. The creation of an automated information management system with modern features is a very effective technique to handle massive amounts of data.

Today, the majority of nations are fully digitalized, and Sri Lanka is making progress in this area as well. The majority of the information in Sri Lanka is maintained using outdated information management techniques, which include a large number of shelves and enormous quantities of files and paper.

The secretarial staff receives the information about the immunized on paper forms. Large quantities of paper are sent in boxes, and it takes a lot of time to go through them all, cross-check each form, and validate it. On the site of the vaccination, there are inspectors who verify the people getting vaccinated by looking at their national identification cards and the information on the form. The divisional secretariat can easily access these files via the system which will be connected via the internet and continue the vaccination program using the automated system if these officials could enter those details into a computerized COVID-19 vaccination information management system with an up-to-date database which will store them.

By comparing the form to the electoral role list and ensuring that this particular person is authentic and has had vaccinations, the divisional secretariat verifies those who have received vaccinations. This list can be entered into the COVID-19 vaccination information management system, and after the officials at the vaccination site enter the details of the people present at the site, the validation can be done by the system itself with absolutely no human intervention, and as a precaution, the divisional secretariat officials can monitor the system's operation, saving time and effort, not to mention the fact that there won't be any errors because there aren't any physical forms present.

The procedure of counting persons who have received vaccinations in the region begins when the validation process has been successfully completed. The present approach requires authorities to manually count each form, which is a tiresome operation with a chance that the count may be erroneous. The automated COVID-19 immunization information management system makes it very simple and quick to handle the counting process.

5. Results and Discussion

In this portion of the study, the analysis's findings are presented. For this study, more than 20 academic online articles and research papers on information management systems and automation were examined. A group of 40 individuals received a closed-ended questionnaire, and 10 system-related employees were interviewed.

The results of the analysis are as follows. The outcome made it quite evident that the manual paper-based COVID-19 vaccine information management system has issues and is in no way time-saving or effective. The results of the questionnaire were crucial in helping to clearly define the issues and what has to be done to complete the output. The qualities and attributes that must exist for the result to be the conclusive response to the assumptions are also included in this output.

This COVID-19 epidemic is affecting the entire world, and Sri Lanka, which is still growing, is feeling the effects to a significant degree. Anywhere in the globe, the COVID-19 immunization program is essential, making efficient information management a top priority. The management of the information regarding the immunized is the responsibility of the divisional secretariat, and it is a manual procedure.

The questionnaire was based on close-ended questions and the interview was conducted with both close-ended and open-ended questions to gain more knowledge on the matter.

The highest responses were received for the following questions,

a. What is the current system in place for managing information of COVID-19 Vaccination?

Figure 1. What is the current system?
Source: Survey Data (2022)

According to the output data, 100% of the sample population stated that the prevailing system to manage the COVID-19 vaccination information is a manual paper-based information management system. This confirms that the current COVID-19 vaccination information management system is a manual paper-based system. Further, this has been cconsistent with Suarez et al. (2021), manual systems have many challenges and patients may hesitate to get their vaccination.

b. Is the current system working properly and efficiently for managing the information?
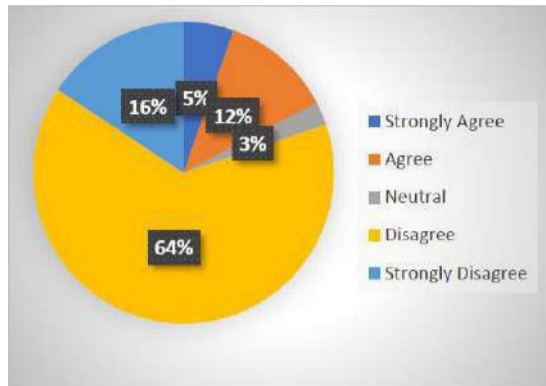
Figure 2. Efficiency of the current system
Source: Survey Data (2022)

The replies about the efficiency of the current paper-based COVID-19 vaccine information management system in terms of completing the necessary tasks for managing the information are shown in the chart. The existing COVID-19 vaccine information management system, which is manual and paper-based, is unsatisfactory to 73.9% of the sample population. The details of the immunized, including their names, addresses, phone numbers, and—most importantly—the day they were immunized, the number of doses they received, and the next date for the second dose—are kept on paper. Massive amounts of paper are used, and the entire process—from receiving the information to validating it and obtaining a count—is carried out by hand. The major reason the system is failing is that everything is being done manually and by hand, which is an extremely time-consuming and ineffective approach to handling enormous amounts of data. To effectively manage and cope with the vaccination information management process, this manual paper-based COVID-19 vaccination information management system should be replaced with a computerized automated COVID-19 vaccination information management system.

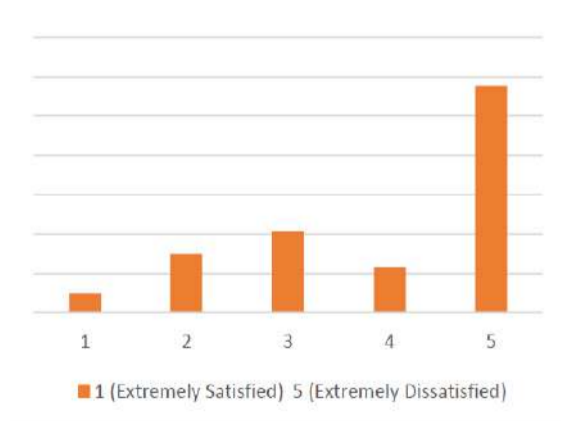c. On scale of 1-5 what is your satisfaction level about current system?

Figure 3. Satisfactory level of the current system
Source: Survey Data (2022)

The figure 3 depicts the satisfactory level of the sample population with the prevailing manual paper-based system. 57.6% have a very low satisfactory level with the current system.

d. Would you like to integrate with an updated computerized automated COVID-19 vaccination information management system?
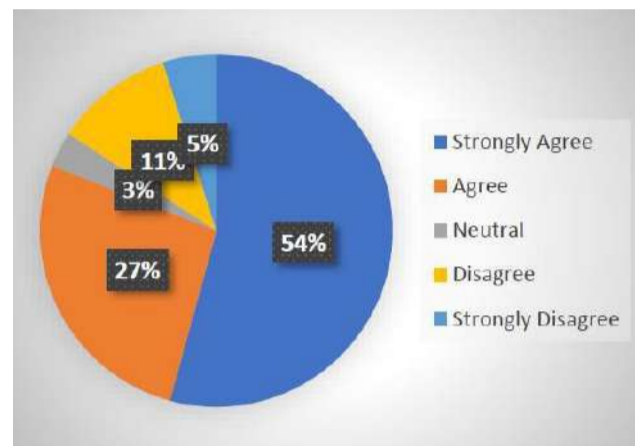
Figure 4. Willingness to use an automated information management system
Source: Survey Data (2022)

In order to handle the information for the COVID-19 immunization program, the following evaluation shows the desire to integrate with a computerized automated information management system. 81 percent of people are open to integrating with a COVID-19 vaccine information management system that is automated.

6. Conclusion

The Corona virus, often referred to as COVID-19, has infected Sri Lanka and the rest of the world. The most crucial factor now is undoubtedly immunization against this terrible virus. Consequently, effective information management is equally crucial. Particularly because this information reveals who has received vaccinations and who has not. This is important because if any one person is not vaccinated, receives too many doses, or receives just one dose, it could result in a variety of issues, including the spread of a deadly virus and health issues from receiving too many doses.

Today's technology is highly developed and has given us a lot of methods to simplify our lives, but we must be careful to utilize it properly. particularly with information management. The link between Sri Lanka and technology has not grown at all. But this little country is gradually catching up with technology, and today, compared to later years, Sri Lanka is in a fairly good technological situation. The usage of technology has significantly grown, particularly because of the epidemic and individuals being stranded at home.

Manual information management systems in general require a lot of human effort and labor and has a very low accuracy and efficiency rate which is why they have to be replaced by automated systems. The COVID-19 vaccination information management is being handle by such a manual system where the officials of the divisional secretariat office are handling all the information manually.

The main goal of this study is to update the manual paper-based COVID-19 vaccine information management system to an automated one in order to address the issues it had. It can be said without a doubt that updating the current manual system to an automated system will not only solve the problems that are being faced, but it will also greatly enhance the accuracy and effectiveness of the information management process for the COVID-19 vaccination program. This research thoroughly analyzed the prevailing problems as well as the assumed solution.

Technology is in the shape it is in today thanks to the efforts of many brilliant minds. Why not employ technology as we are now in its golden era. Let us employ technology to resolve issues like the one this study article focuses on. We Sri Lankans are a proud people, therefore let's employ technology ethically and go ahead into the future.

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Development of Flexible Airline Reservation System using Quality Attributes for Domestic Airlines in Sri Lanka

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Abstract: The airline industry is characterized by rapid change, innovation, and new technology. It is a fast-growing industry with annual revenues in the millions of dollars. From the up-sky, travellers could experience breath-taking views of Sri Lanka. So, using domestic airlines is the best way to travel in Sri Lanka. Therefore, local airline websites must be developed. However, there is fierce rivalry in the airline industry because everyone is striving to be the best to gain their market share through various strategies such as offering excellent customer service, low-cost fares, and other perks for travellers. To accomplish those tasks, the researchers identified the importance of developing a web application through an investigation. Researchers identified the challenges faced by the flight seekers and administrators of the airlines through many problem identification techniques. Functionalities that will be supported to improve the efficiency of the domestic airline reservation system were authorizing an administrator to manage all the passenger details and flight details, developing a more secure system, automating the e-ticket generating system, improving user satisfaction by enhancing the user experience, reducing the developing and maintenance cost, encourage the users who have a low level of computer literacy to use the system. So, the researchers' main aim was to develop the application by enhancing the above-mentioned functionalities. For that researchers decided to use features such as tokenization, bar code generators, report generators, and automated ticket generators. After the successful development researchers have done a system test by contributing domestic airline users. Through the analysis of testing results, all respondents have been satisfied with the successful development of the domestic airline reservation system.

Keywords: Domestic Airline Reservation, Flight-Booking, Web-Application

1. Introduction

Air traveling is the easiest and most efficient way to travel inside the country since the local roads may take much time even though it is cheap. Developers hope to create a domestic airline reservation system for Sri Lanka. A domestic flight is a flight that departs from and returns to the same country. Tourism is one of the main sources of income in Sri Lanka. Today, the tourism industry of Sri Lanka is developing, foreign tourists like to experience the beauty of nature, explore ancient cities, and spend their time with their favourite activities. Hence, travellers will need to travel across the country quickly and easily without any hesitations. The airline reservation system project is an implementation for an airline ticketing website. The airline reservation system project is for the domestic airline ticketing website. Airline organizations arranged flights on a low budget for tourists since the demand is still very low. As a result, such organizations do not make a big profit. That is the main reason they could not afford web systems which cost a lot. And the researcher found that there are some challenges faced by the users of domestic airline reservation systems. Identified challenges of existing systems were dissatisfaction with the user interfaces, need for better computer literacy and operational handling, unsecure flight bookings and payment transactions, and the inability of generating an e-ticket. Therefore, researchers aim is to design and develop a domestic airline reservation system that can overcome the above-mentioned challenges. The main objectives of the research are to understand the problems in existing and current systems and implement a more efficient domestic airline reservation system that can achieve the aim, then test it by giving it to experienced users and evaluate the test results and conclude.

2. Literature Review

Since researchers wanted to get more knowledge in this area to fine-tune our objectives, researchers decided to refer to some profuse research papers. When researchers refer to the projects and the research papers available on the internet which are based on Airline Reservation Systems, there are particularly important factors for us to know about existing systems in this field. We were able to get a clear idea about how they developed those systems and what are the technologies that they have used. So below is a clear summary of the research papers that were referred by researchers for designing our airline reservation system.

According to the "An Overview of NLIDB Approaches and Implementation for Airline Reservation System" by Mony, Rao, and Potey (2014) this research is to compare the approaches of Natural Language Interfaces for Databases (NLIDB). Also, to examine the advantages and disadvantages of NLIDB. And, finally to implement an approach for a flight reservation database. NLIDBs are systems that convert natural language sentences into database queries. These systems allow users to interact with the databases directly by entering the commands in natural language. The Intermediate Query Approach makes it simple to map identified concepts to an intermediate representation. And when developing the system, they used Java, Spring framework, and MySQL databases. After

developing the software, the software is tested by running natural language queries and retrieving the results. Authors have mentioned that the NLIDBs' future scope could be focused on obtaining domain independence.

Presented paper under the topic of "Development of a Mobile Airline Reservation Application" by Alo et al. (2012) focus on developing a mobile application for air ticket bookings anywhere, anytime and saves cost and time because mobile applications are becoming more and more common in people's daily lives. Here, researchers have discussed the software architectural design of the proposed mobile airline reservation system. The main function of the system is to make the process of booking a flight a simple and trustworthy manner. Because traditional reservation records have many drawbacks like incomplete, misplaced, or loss of records. Furthermore, the systems produced by foreign countries are very expensive to use. And the mobile airline reservation system application was developed using Xcode for software design on iPhones and Java for the development on BlackBerry phones. C#.Net is used for the front-end and SQL server is used for the back-end.

The paper "Investigating the factors influencing users' continuance intentions towards online reservation" by Mouakket, (2013) helped us to get the idea of how to build a system that can keep their customers using these online websites continually. This research shows the roles of hedonic value and subjective norms in motivative continuance intentions towards using online reservation systems. In this paper, they posit that the expectations of people who are important to a customer, such as relatives and colleagues, influence their continuance intentions towards using an online reservation. Thus, the following hypothesis is formulated: H6: Subjective norms have a positive influence on continuance intentions. After analysing the data gathered the study has found that hedonic value within the online reservation context, is consistent with previous studies in web-based applications. And the findings conclude that while utilitarian value positively influences satisfaction, hedonic value has not shown a positive relationship with satisfaction for online reservation customers. And, that satisfaction, usefulness, and subjective norms are important factors when motivating customers' continuance.

"The case study on airline reservation" by Williams et al (2020) discusses their developed framework to demonstrate how the idea of web services can be utilized for online airline reservations by using the finite automata computational model. This model is a fundamental computing model that presents sufficient behaviour of the service based on its user consideration. In this paper, the researcher has tested two types of finite automated models as; Deterministic Finite Automata (DFA) and Nondeterministic Finite Automata (NFA).

These are tested with the JFLAP simulation tool to measure the effectiveness and efficiency of online airline reservation optimization. Researchers have proved how NFA and DFA can be used to indicate the transition flow of an online airline reservation with the given simulating input. The finite automata are an advantageous technique in web service testing and can confirm the test suite used in the study.

The research "Issues with flexibility: A reason for not using online reservation systems?" by Mushtaq, Loviscach, and Sulaiman (2010) says the results indicate that flexibility, rather than functional requirements, has a substantial impact on the perceived usefulness of online reservation systems. Using an online reservation system to book a ticket typically results in lower transaction fees. This research is based on a survey questionnaire that was issued to airline passengers. To test the model and the above hypotheses, a questionnaire was created. The incorporation of flexibility has a considerable impact on the usability of online reservation systems. Secondly, relationships between functional requirements and online system usability are thought to have a minor effect on each other.

The paper by Ele, Agana, and Bukie (2018) "A Distributed Airline Reservation System for Nigerian Airline Companies" focused on the development of a distributed airline reservation system and resolving problems of the current reservation systems. For their flights, airlines have also set up a distributed reservation system.

Each airline had a system, that was not connected to other airlines or ticket agents. This technology is used to handle airline bookings and connects with a global distribution system (GDS), which allows travel agencies and other distribution channels to make a reservation for most major airlines in one place.

Mushtaq and Riaz (2016) presented a paper on the topic of "Flexible Airlines Reservation Systems Using Service Quality Attributes of Airlines". According to the authors, the scope of this research is to examine the flexible behaviour of travellers to design an online airline. With a more flexible reservation system. The flexible behaviour of the users is examined from the perspective of cognitive psychology. And Human-Computer Interaction (HCI) explains the interaction between humans and computer technology. To explain human behaviour, HCI has deployed many theories, principles, and concepts such as Perception, Memory, Language, and Thinking. According to the research paper, having a clear understanding of user behaviour will help web designers to develop websites flexibly and effectively. Furthermore, travellers' desire for affordable prices is a major consideration when developing a flexible system. This study is based on a survey questionnaire that was issued to airline passengers. And, to determine external variables' association with flexible behaviour of travellers, has used Pearson Correlation Coefficients and Multiple Regression Analysis. The results obtained using Pearson Correlation Coefficients of quality service are statistically significant. And Multiple Regression Analysis shows the relationship between service quality attributes of airlines, external variables, and flexible behaviour of travellers. Finally, the paper implies

that the usability of the website cannot be improved without considering customer intent and user behaviour.

Law and Leung (2000) presented a paper on the topic of "A Study of Airlines' Online Reservation Services on the Internet". Researchers say that making travel plans via the Internet is the second-largest commercial segment on the Internet. According to the authors, the main goal of this research paper is to investigate airline online reservation services and the benefits offered to clients who use the internet. In the paper, it has shown that many people access the Internet to get flight information and make reservations. In the paper, the authors have mentioned that there should be an online catalogue that gives all the data a customer requires to make a buying choice such as air ticket price, schedules, flight availability, and updated contact numbers for making reservations. And also, the efficiency of an online reservation system in terms of processing time is an important aspect that draws travellers to purchase air tickets online. If the web page contains a lot of graphical images, then it will take a long time to load the page. So, web designers should aim to avoid putting substantial content on the main page and instead keep it simple with links to linked sites. Here, researchers have observed what are the things that should be changed, what things should be included, and what are the qualities and services of an airline reservation system. These reservation services were categorized into flight schedules and availability, air prices, and online ordering information. At the end of the research, results showed that the most comprehensive airline Web sites were in the North American region. Furthermore, the results of this study demonstrate that credit cards were the only method of payment for online air ticket purchases. Finally, the purpose of this study was to examine the essential features and benefits offered by airline websites to their clients.

3. Methodology

With the recent evidence of the researcher, the research philosophy of this research is to develop an airline reservation system by enhancing the maintenance efficiency and decreasing the cost while increasing the user interaction with the system. The researcher has gone through the hypothesis of developing an easy, reliable, and well-secured system for users. It also aims to create a system that can be easily maintained by small organizations. So, the researcher has used the deductive approach while implementing this system.

The researcher intended to carry out some research strategies through both qualitative and quantitative methodologies. A survey is a method that the researcher used to collect rich and reliable data. The survey was passed among the people who are in groups on WhatsApp & Facebook which are based-on flights. Case studies focused on the background area of airline reservations. For this research cross-sectional time frame was used by the researcher. As the proposed system is going to develop for the Domestic Airlines in Sri Lanka via the sample

population consisting of the main users as Passengers, Viewers, and Admin. With the support of those actors, the data collection process was done through Questionnaires and Interviews.

A. Questionnaires

The questionnaire was distributed through two main sections as Aviator Section and Passenger Section. The researcher gave different questions to each section. A questionnaire was provided to the aviators like Pilots, Student Pilots, Aviation managers, and Administrators of Airlines. And the questionnaire was passed among the passengers who are in groups on WhatsApp & Facebook which discuss flights.

B. Interviews

Since there were a lot of users of this system, the researcher decided to interview only the main administrator (Director Operations) of this system as he shall be maintained and manage all these data. The researcher understands the expectations and the requirements of the administrator using the interview.

With the evaluation of both questionnaire and the interviews, the researcher identified the necessity of an online airline reservation system, the pros, and cons of the current applications, challenges faced by the users, and factors to be considered to increase the support of managing the system, the important functions which need to be included in the proposed system.

By examining all those data researchers came up with a conclusion of proposing a new airline reservation system.

4. Proposed System

The following diagram illustrates a simple conceptual diagram that elaborates the concept of implementing an online airline reservation system.

Figure 1. Proposed System Architecture

There is only one main login interface in this system for admin. This proposed system can be accessed by the administrator, operation staff, and passengers. Furthermore, each administrator and operational staff have a unique username and password provided by the system when they register. Passengers have the ability to access the system without registering for the system. There are major functional requirements are listed below.

Administrators are able to,

- Add flight details (chartered/ scheduled)
- Remove flight details
- Update flight schedules

- Add another administrator
- Add reservations
- View passenger details, edit & delete details
- View payment details
- Inform flight cancellations
- Add/ Update Gallery
- Manage inquiries
- Add Promotions

Passengers are able to,
- View flight details (Chartered/ Scheduled)
- Book flights
- View Gallery
- Get promotions
- Make inquiries
- Make payments
- Get E-tickets

5. Implementation

A. *Login Module*

The system comprises one login interface which is only used for administrators to access the admin panel. The distinctive feature of this system beyond the other existing system is passengers do not need to create an account to make use of the functions of the system. The reason for adding this functionality is because that customer does not use domestic flights frequently in their day-to-day activities according to the analysis investigation done by the researcher. The only administrator has the ability to give access to other airline admins to the system.
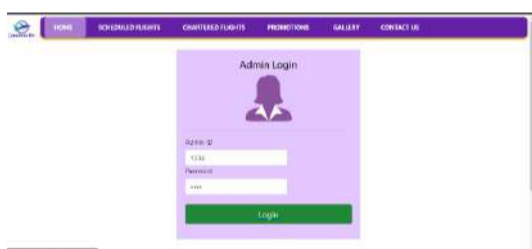
Figure 2. Admin login interface

B. *Flight Details Module*

Most existing systems in SL are still using the hard-coded systems without the contribution of the admin panel. The importance of this system is having an admin panel that has CRUD operation functionality which deducted the need for hard coding the details to the system. Here, the administrator has the authority of handling both chartered and scheduled flights.
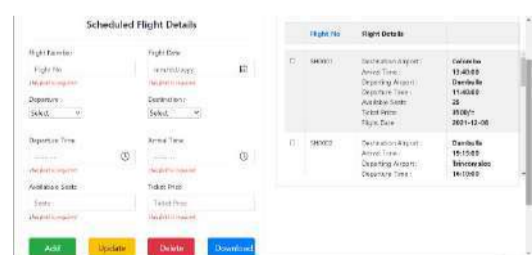
Figure 3. Admin panel of scheduled flight details interface

The user has the below-mentioned interface to check the scheduled/charted flight details. Then they can explore through the booking.

Figure 4. The user interface for scheduled flight details

C. *Flight Booking Details Module*

This module allows administrators to add new flight booking details and update/ delete those details. And especially he/she has the ability to download the passenger details of the booking. The significance of this functionality is it improves the efficiency of storing and sharing booking details of flights.
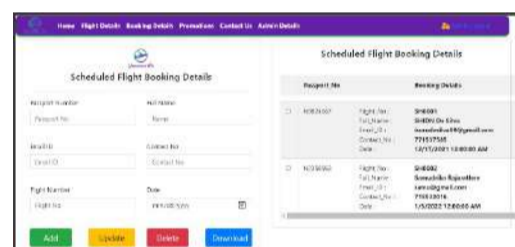
Figure 5. The user interface for users Flight booking details

D. *Promotion Details Module*

The promotion details module helps to enforce the customer interaction with the application and use this for their flight bookings. Enhancing customer satisfaction will encourage to increase in the profit of the airline company. The administrator has the authority of promotion management.
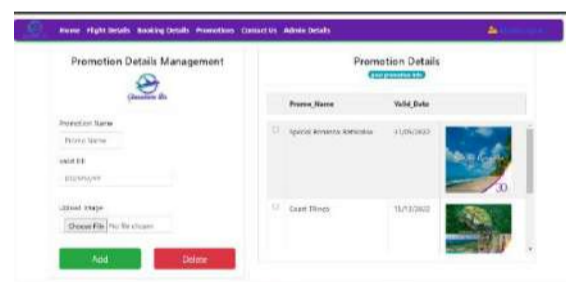
Figure 6. Admin panel of promotion details
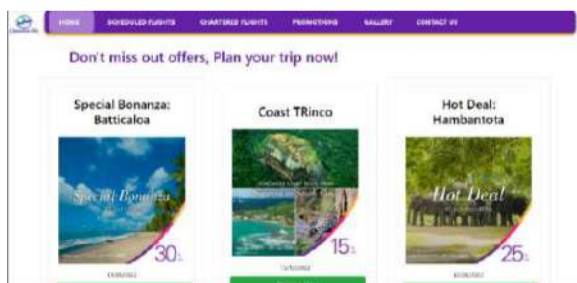
Figure 7. The user interface of promotion details

E. Contact Details Module

If a user has inquiries about flight details, he/ she has the ability to use the contact us module. Then, the administrator receives the inquiries of the user. So, the administrator can download and manage the requested details.
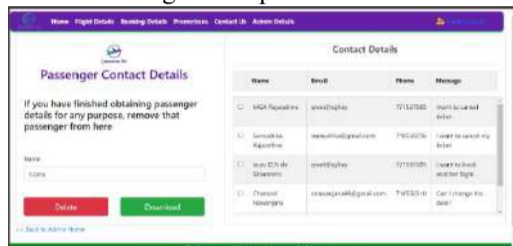
Figure 8. The admin interface of contact details
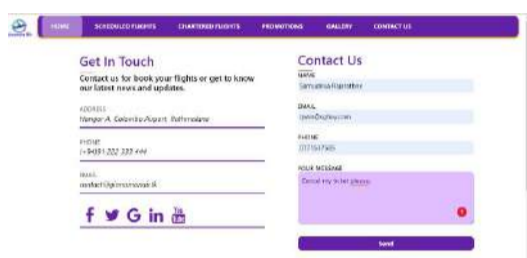
Figure 9. The user interface for contact details

F. Payment Module

After choosing the suitable flight, user can enter their required details to move to the payment interface.
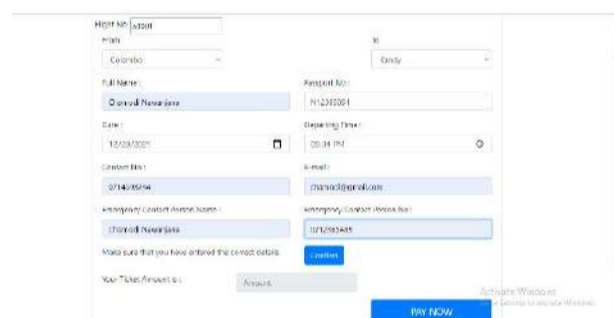
Figure 10. Payment details interface

User has the potential to use the preferred payment method to purchase their flight ticket.
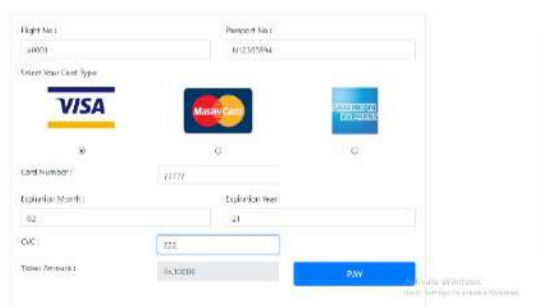
Figure 11. Payment module interface

G. Flight Ticket Module

After the successful payment, an electronic ticket receipt will be generated automatically. Then the user can save it to their devices' local storage.

Figure 12. Generated E-Ticket

H. System Requirements

The system architecture used to develop this system is a layered architecture. When it comes to the project's overall technical architecture, mainly researchers used the Visual Studio 2017 ASP.NET framework with C# as the main programming language. To design the user interfaces of the web application researchers have used HTML and the bootstrap framework. Microsoft SQL is an open-source database that provides comprehensive support for this kind of application development needs. Hence, the developers used Microsoft SQL as their database.

I. Technical Feature Extraction

Another novelty of developing this system was the proper usage of a combination of features to overcome the challenges identified. Given below are some novel features that the developer has used when developing this system.

Users place high importance on data security since the services' related data are stored on remote platform servers, which are located outside of their physical location. It is important to provide a protected environment for the client's commercial and personal data. As the clients use their card details to make their payments through our payment gateway there is a risk of hacking the card details. To avoid that researchers have used token API which is having high restrictions on authentication. The researcher has used tokenization that will be more supported for the .NET framework.

To increase the efficiency of this system, report generators are used. Because report generators will ease the task of managing the passenger and flight booking details. As this is a C#.Net framework-based application, the developer has used Aspose document API which is feature rich and powerful. And also, it supports all popular loading and saving formats.

Generating an e-ticket is one of the main features applied to this domestic airline reservation system. So, applying a bar code to this will prohibits anybody with fake, duplicated tickets from entering. The developer found that the BarCode NuGet package library for C#.NET will be more supportable for the barcode generator in this system. Also in this system design, there is no need for third-party services for paying a subscription fee. All the required functionalities are built-in to the system by the developers. That will cause a reduction in the total cost of the development.

6. Testing and Evaluation

Before sending out to the outside testers, developers have to evaluate the system by using some testing methods. Such as unit testing and integration testing. The researcher used the acceptance testing (beta test) to get the contribution of involving the external parties to evaluate this system. To evaluate this system researcher got the contribution of two parties. Those parties were airline administrators & flight seekers. Through the management process of certain modules, the system's features are evaluated as modules.

A. *Evaluation of administrator*

And researcher has taken the contribution of Sri Lankan domestic airline companies to evaluate this system. After the testing procedure conducted by administrators, they have given their overall final opinion of this newly designed system. The pie chart below shows the percentage of preferences for this system.

As the administrators, have you found out that this newly designed system is better than the existing system?
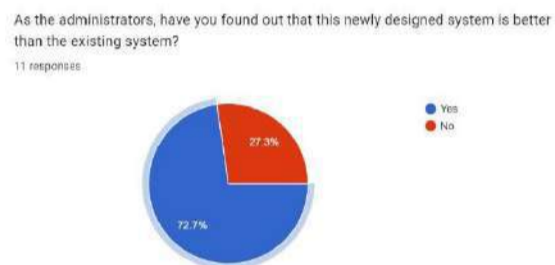11 responses

- Yes
- No

27.3%
72.7%

Figure 13. Administrator opinion analysis

This chart shows that a high percentage (72.7%) of administrators have suggested this as a better application for managing their daily tasks.

But some of them do not give a good reaction to the performance of this system. They have suggested some functionalities to be modified in this system. Those are:
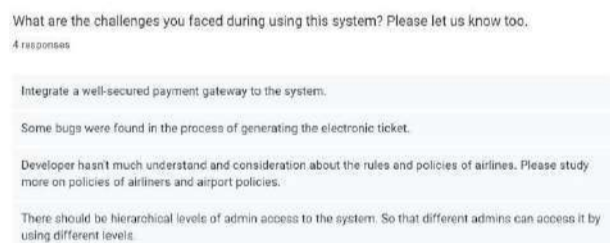

What are the challenges you faced during using this system? Please let us know too.
4 responses

Integrate a well-secured payment gateway to the system.

Some bugs were found in the process of generating the electronic ticket.

Developer hasn't much understand and consideration about the rules and policies of airlines. Please study more on policies of airliners and airport policies.

There should be hierarchical levels of admin access to the system. So that different admins can access it by using different levels.

Figure 14. Suggestions of the Administrators

B. *Evaluation of flight seekers*

In addition, the system efficiency was evaluated using 57 flight seekers. The researcher has given this system to colleagues, relations, and neighbours who are using frequently using reservation systems.

As the users, have you found out that this newly designed system is better than the existing systems?
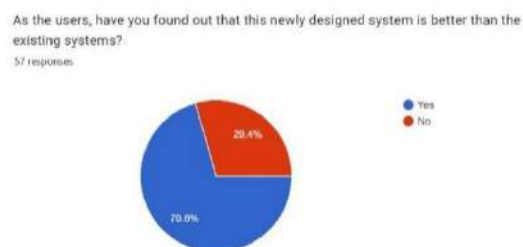57 responses

- Yes
- No

29.4%
70.6%

Figure 15. User opinion analysis

Most of the respondents (70.6%) agreed with this system. So, they understand that this will overcome the problems in the existing airline reservation systems.

Some users found some problems with this system. So that they have put "No" as their answer to the above question. Then some of them have suggested some areas to improve in this system. Those are:

Have you find any problems with using this system? Please let us know too.
3 responses

Can't select preferred seats. Please implement that function too. Others are okay for me.

Non-notification of passengers of flight cancellation or delays. There should be a way to cancel the flight in the system itself.

Passengers don't have access to aircraft maintenance report to ease the fears associated with air travel and its disasters.

Figure 16. Suggestions of the flight users

7. Conclusion

This automated domestic airline reservation system provides a successful, effective, and efficient way for users and administrators. The key purpose of the implementation is to check whether the developed system is fulfilled the user requirement and confirms the test results expected under a wide range of conditions. To accomplish this flight reservation process easier, the researcher applied a web-based online flight reservation system as it will be able to address the real problem encountered by the user with the existing system. The significance of this reservation system is reducing various costs (especially maintenance costs), time-wasting which is going to the agency or office, decreasing the paperwork, and helping in easier record maintenance by having a centralized database system. The user can book a flight from anywhere within a short period. The web system provides a quick and reliable process hence reducing the load of work done manually and saving time for both user and admin. From the system, it replaces a load of paper works such as ticket printing, and document printing to a few computers. Therefore, the system will be a solution for minimizing resource wastage. The identified solutions provide many direct and indirect solutions to the airliners via this system.

8. Further Works & Recommendations

The researcher indicates some suggestions for improving the coherence of the system by adding the functionality of accurate seat reservation, automated flight cancellation process, agent communication process through chatbots, and process review system. These functionalities will take a prominent place in improving the efficiency of the airline reservation system.

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A Systematic Approach to detect and manage Academic Stress of University Students using Emotional AI

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Abstract: Stress is a prevalent issue that affects all of us at some point in our lives. The most common sort of stress that university students suffer is academic stress. This has a huge possibility of harming a university student's academic performance. According to the research findings stress is caused due to assignments on time submission, GPA Values, Modular Grades, and Loss of Hopes and Ambitions. Also, the personal coping mechanisms used by university students to manage academic stress are listening to music, watching videos, being motivated, and working hard, and wishful positive thinking. Moreover, the data gathered shows that there is a significant relationship between the ability to manage stress levels, gender, academic year, or university type of undergraduate students. Academic stress has become a part of university students' lives; at times, it encourages them to improve themselves and work hard; at other times, it has become a burden when they are unable to manage it. So, therefore, this research paper is concerned with proposing a system to detect stress levels and manage academic stress of university students through stress- releasing mechanisms that will assist university students in reducing stress levels caused due to many factors using various strategies. This proposed system uses Emotional Artificial Intelligence to detect students' emotions and identifies stress levels through Text Input (natural language processing), audio (voice emotion AI), video (facial movement analysis, physiological signals, and other factors), and system assists university students for various stress reduction techniques

Keywords: Academic Stress, Stress Reduction System, Emotional Artificial Intelligence

1. Introduction

The feeling of being overwhelmed or unable to cope with mental pressure is referred to as stress. Academic stress, on the other hand, is the body's response to academic demands that exceed students' adaptive capabilities. Academic stress has recently become a major concern for students around the world. As a result, students may fail in both their academic and career lives due to emotional stress. According to the World Health Organization, a student's physical and mental health must be adequate for them to actively participate in academics. Academic stress can cause university students to drop out of school or university, which is a problem. Academic stress has a negative impact. University students are under a huge amount of pressure as a result of their academics. Students' stress management abilities must be improved, and this is one way to do so. It is critical to developing coping techniques to overcome academic challenges. This proposed system uses Emotional Artificial Intelligence to detect students' emotions and identifies stress levels through sources like Text Input (natural language processing), audio (voice emotion AI), video (facial movement analysis, physiological signals, and other factors) and system assists university students for various stress reduction techniques.

A. Research Problem
How to detect and manage academic stress levels among university students which affect their performance using a system with the aid of Emotion Artificial Intelligence.

B. Research Aim
Propose a system to detect stress levels and manage academic stress of university students through stress-releasing mechanisms

C. Objectives
- Identifying the academic stress-causing factors of university students
- Identifying the coping strategies used by university students to reduce academic stress.
- To Propose a System to detect and manage academic stress

D. Limitation
The study's target population is all Sri Lanka's university undergraduate students, including state and private. However, surveying the entire population was impossible and impractical. As a result, a group of 300 students was chosen to continue this study.

Mobile applications, movies, audios, and online consultation services are now available to help people to cope with their stress as a result of technological advancements. However, there is currently no appropriate technological solution for stress detection and management among young university students. The usage of technology by the younger generation is growing at an exponential rate, and they have very tight schedules due to the demands of their daily lives. As a result, the goal of this study is to figure out how to use technology to help young university students to manage their academic stress while also achieving their academic and personal objectives.

2. Literature Review

Stress is a condition of mental pressure for a particular individual facing problems from environmental and social well-being. Young age is the critical period because at this time youth faces lots of changes in his/her life. Findings will help individual students, scholars, lecturers, and career and counselling centres. (Bhargava et al.,2018)

Stress has become part of student's academic life due to the various internal and external expectations placed upon them.
Adolescents are particularly vulnerable to the problems associated with academic stress. Understanding sources of stress would facilitate the development of effective counselling modules and intervention strategies this study has proposed sources of stress that would facilitate the

redevelopment of effective counselling modules and intervention strategies by school psychologists and counsellors to help students alleviate stress. The drawback is that there is no recommended technological invention to detect stress and emotions. (Reddy et al., 2018)

Here this study has found that Stress is one of the top five threats to academic performance among college students globally. No study has assessed the practice of stress management behaviours and associated factors among undergraduates at Mekelle University, Tigray, Ethiopia, 2019. The study found that the majority of the students had a poor practice of stress management behaviours. The drawback is that there are no suggestions about stress detection and stress relaxation methods for stress levels of students. (Hailu et al.,2020)

Use of Technology
This research has developed a system to detect the stress and strain that people nowadays are facing. This software captures the image from the camera and after processing makes the decision. The drawback here is that this study has only used the approach of capturing images from a camera; there is no voice recognition or text analysis used to estimate stress levels, and also there are no stress-relieving mechanisms proposed through this study. (Rajasekar et al., 2020)

This study has developed a system that uses a machine learning approach in stress detection using sensor technology. Data provided from a physical activity tracker device Fitbit. The drawback is that, even though this study has managed to identify stress using sensors and physical activities, there is no indication of stress-relieving techniques as a solution to stress. (Padmaja et al., 2018)

This research study has developed a system when a high-stress level is detected, it suggests the most appropriate relaxation method by analysing the physical activity-based contextual information. The drawback is that the system will suggest only a relaxation method for high-stress levels not for moderate stress levels. Moderate stress levels should also be reduced through appropriate relaxation mechanisms. (Can et al.,2020)

This study has identified that Stress has become a significant cause of many diseases in modern society. Recently, smartphones, smartwatches, and smart wristbands have become an integral part of our lives. The technology of detecting and preventing stress with smartphones and wearable sensors has been used. A gap in this study is identified is that the stress detection process is done using sensor technology, not through emotional Artificial Intelligence. (Said et al.,2019)

As this study states Stress is the body's natural reaction to external and internal stimuli. Despite being something natural, prolonged exposure to stressors can contribute to serious health problems. This study has proposed a stress-detection system that is non-invasive, only requiring a webcam to monitor the user's facial expressions. The research gap identified is that there is no Voice and Text Detection in this proposed system. (Almeida et al., 2021)

Comparison

Table 1-Related Work Comparison

Related Work	Face capture and Detection	Voice Recognition and Detection	Text Analysis and Detection	Stress Releasing Mechanisms	Sensor Technology	Analyzing the physical activity-based contextual information	Bio Signals
Machine Learning Based Emotion Detection and Stress Relief Application	✓	✗	✗	✗	✗	✗	✗
Machine learning approach for stress detection using wireless physical activity tracker	✗	✗	✗	✗	✓	✗	✗
How to relax in stressful situations: A smart stress reduction system Healthcare	✗	✗	✗	✓	✗	✓	✗
Stress detection in daily life scenarios using smart phones and wearable sensors: A survey	✗	✗	✗	✗	✓	✗	✗
Facial Expression Recognition System for Stress Detection with Deep Learning	✓	✗	✗	✗	✗	✗	✗
Emotional Stress Recognition System for Affective Computing based on bio-signals	✗	✗	✗	✗	✗	✗	✓
Proposed System: Emotion Detection and Stress Reduction System	✓	✓	✓	✓	✗	✗	✗

Research Gap

The suggested research solution differs from the existing systems since it combines three technologies: face capture and detection, speech recognition and detection, and text analysis and detection, which have not been combined in one system in previous studies.

3. **Methodology**

A. Data Collection
A survey was created to get enough responses covering the area of university students from both state and private universities. The contribution of this study is to identify the main stress factors and personal coping strategies used by university students under Academic Stress. Information was collected using a Google form and then entered into a database, such as an excel sheet, to track and organize the data. The questionnaire was distributed among the target sample using social media platforms such as WhatsApp, Facebook & Instagram a reached up to 300 responses. Quantitative data was deciphered using descriptive analysis.
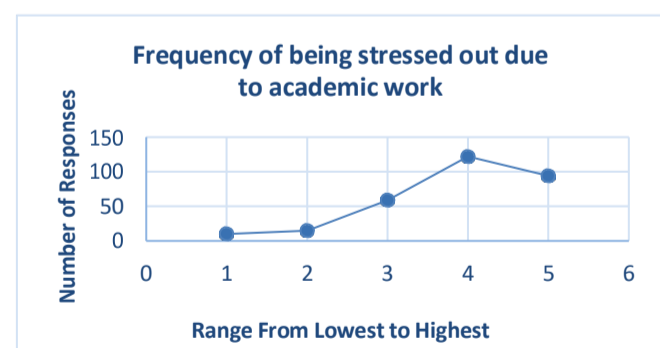

Figure 1-Frequency of being stressed out due to academic work

Out of 300 respondent's majority of the respondents have felt stressed out due to academic work

Figure 2-Lack of Self-Confidence

As indicated in the above Line chart, the majority of university students lack the confidence to manage all of the academic work stress, so proposing an effective stress reduction system is more appropriate.

In addition to that, a questionnaire was sent, and an interview session was kept with a counsellor to collect and analyse data regarding the identification of stress and advice given to manage stress. According to the information acquired from the counsellor, looking at a student's physical appearance stress can be detected psychologically. Students' stress levels can be determined by looking at their eyes, skin, hair, mood, how they are dressed, and how they speak. In addition, the counsellor also stated that dark circles under the eyes, thinning hair, always pre-occupied, not paying full attention when engaged in conversation, short-tempered, addiction (caffeine, nail-biting, etc), absentminded, lack of concern about how one is dressed, binge eating, physical pains, and breathlessness are some of the symptoms that can be identified from a student who is under stress. The counsellor also mentioned that empathetic listening and asking the right questions can help to identify psychological stresses in students. The thoughts and feeling or habits that a student goes through will lead to his/her stress which can be identified by talking to the student such as improper time management, frustration, irritability and edginess, insomnia or disturbed sleep, confusion and forgetful, racing thoughts, difficulty in concentrating and processing new information, worry over Peer pressure, parental pressure on academic performance, Unhappy, insecure feeling, feeling hopeless, Less sociable, hostile behaviour if these factors are identified while engaging in a conversation with the student, it can then be identified as the causes for the stresses a student is going through. Counsellor assures that identification of stress is possible by analysing the writing style and content. If the messages are very negative, rushed, and make no proper sense, consist of a lot of complaints that stress can be identified through text messages on the things the student has said in the messages and from the style of writing. However, it is not highly recommended since there is a tendency for misinterpretation. The stress coping solutions that counsellors suggest for students who are struggling with academic stress are to get enough sleep to keep both the mind and body more alert and active, to get organized and be systematic by maintaining a to-do list and prioritizing your work, Optimism helps to turn negative stresses into positive stresses, pray for guidance in the right direction and to believe in themselves.

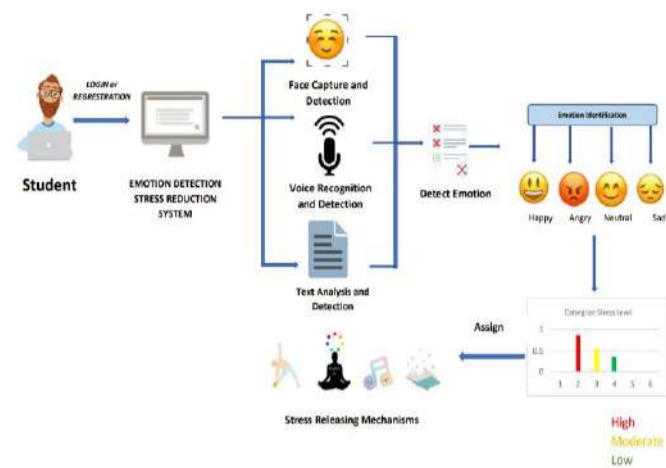## A. The High-Level Architecture of the System

Figure 3-System Architecture

Emotional Artificial Intelligence is proposed to detect the stress levels and the emotions of the University students

When a student logs on to the system after registering, they are been directed to these three technologies to detect their academic stress levels and emotions.

1. **Face Capture and Detection-** When a student faces his/her face the web camera enabled in the system can detect and capture the students who are under stress by detecting these such as deeper lines around the middle of the eye's forehead, undereye, and lips are identified. Identification of rashes and pimples on the skin of the face. Dark circles, swollen eyes, and a pale complexion of the face are all detected by the system. Lip biting, pursed lips, inner corners of lips pushed down, inner corners of eyebrows lifted, and eyelids lose are all signs of emotional sadness and stress.

2. **Voice Recognition and Detection-** This system has a voice assistant enabled that asks questions from the logged-on student. A certain number of questions are asked to assess the students' stress levels. The conditions like muscles in the chest, throat, neck, jaw, and vocal folds tighten a shift in tone, and clearing the throat when speaking is identified as signs of stress through the system.

3. **Text Analysis and Detection-** Textual data is used to detect stress in this case. It has been recognized based on the responses that students type into the system in response to the questions. The system recognizes unusual texting patterns and styles. When the responses are not consistent, words like "hmm," "I'm not sure,", "I guess,", and "will see" are used to answer questions that are being identified using the system.

Using these three technologies Emotions of students are detected and categorized as Happy, Angry, Neutral, and Sad, and also whether the stress level is High, Low, or Moderate. Afterward, University Students are directed to numerous stress-relieving mechanisms and strategies

through the system. In addition to that students can also request appropriate and other best solutions from the voice assistant enabled in the system.

A. Design Diagrams for the Proposed System

The figures represent the Class diagram and the Use Case diagram which explain the process of the proposed Emotion Detection and Stress Reduction System for university students
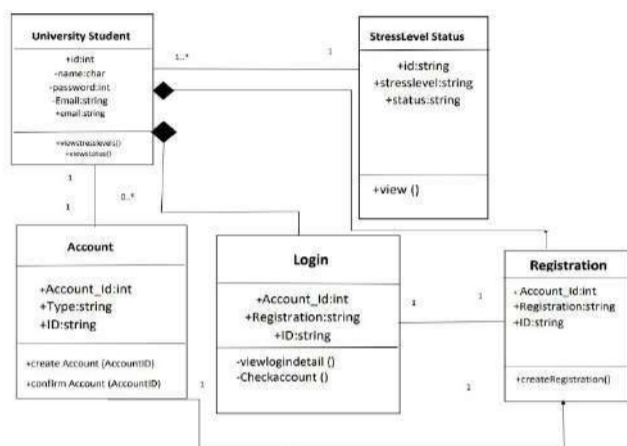
Figure 4-Class Diagram
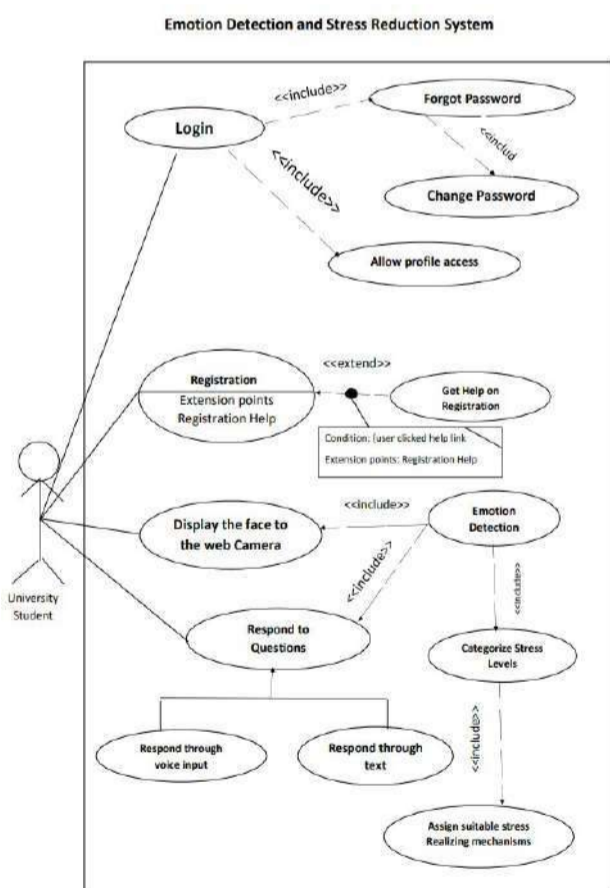
Figure 1-Use Case Diagram

A. Proposed System Design

The proposed system is named **"Serene"** which is being calm during a Stressful Situation.
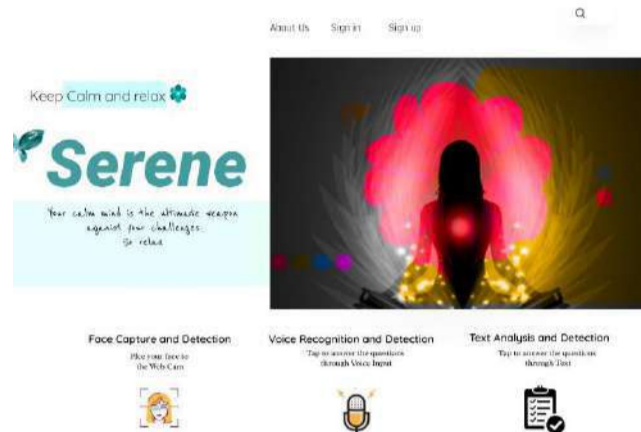
Figure 6-Proposed Design Interface
for Emotion Detection

After the emotion detection process, the proposed system directs university students to use these stress coping mechanisms to manage academic stress levels. **Ultra-hypnosis** uses breathing exercises with breathing in and breathing out, **Time Tracker** when a student starts doing something, he or she can set a new timer, and this time tracker will track the time. When the student finishes the activity, they must terminate the timer by indicating what they have been doing at the time, and this generates a weekly report of analytics of what projects, assignments, and other academic work they have been working on, as well as the time spent on them. Students can do **exercises, workouts, yoga, and meditation** to calm down stress. This system includes **audio** of books and articles related to motivational content. It allows students to design and organize module-related colourful **mind maps. It includes reminder alerts** of assignment deadlines, project and research paper submission reminders, submission reminders, and pop-up notifications. **Art and audio therapies, Self-Care reminders to remind students to drink water and stay hydrated which shows many litres of water a student should drink according to their BMI, and Community Forms allow students to talk with another about what they are feeling. Wall Planner, Calendar, Workload.**
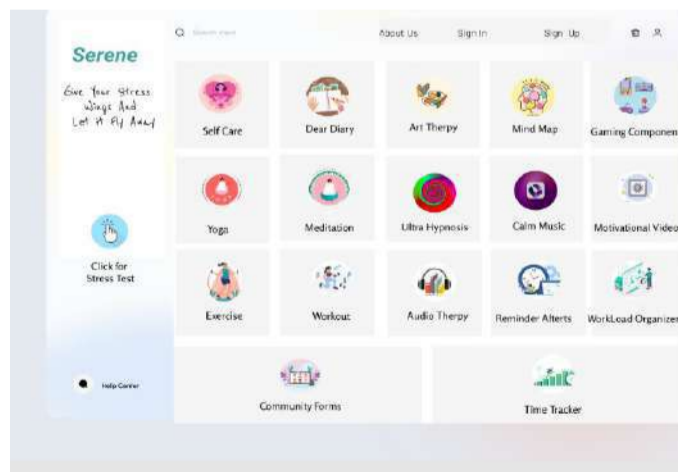
Figure 7-Proposed Design
Interface for Stress Reduction

4. Results and Discussion

The google form was analysed according to the data analysis plan and then the results were gathered. The below table shows the Demographic factors of the respondents regarding the ability to manage their Stress according to university, gender, and age categories of university students. The majority of the students are unsure about their ability to manage their stress levels. Moreover, it shows that there is a significant relationship between stress levels and gender, academic year, or university type of undergraduate students

Table 2-This pivot table depicts the Demographic Factors of Stress

| Demographic Factors	University					State Total	Grand Total
	Private		Private Total	State			
Age-Ability to Manage Stress	Female	Male		Female	Male		
18-20	11	4	15	1	1	2	17
Maybe	3	3	6	1		1	7
No	4		4		1	1	5
Yes	4	1	5				5
20-22	55	21	76	48	11	59	135
Maybe	27	12	39	25	2	27	66
No	3		3	2	1	3	6
Yes	25	9	34	21	8	29	63
22-24	41	18	59	40	27	67	126
Maybe	13	8	21	19	7	26	47
No	4		4	2	1	3	7
Yes	24	10	34	19	19	38	72
24-26	4	3	7	7	7	14	21
Maybe	2	3	5	3	2	5	10
No					1	1	1
Yes	2		2	4	4	8	10
above 26					1	1	1
Yes					1	1	1
Grand Total	111	46	157	96	47	143	300

According to the below table assignments on time submissions are the most prevalent source of stress in the academic lives of university students. It is 209 out of 300 respondents, or 69.7%. Second, Project Deadlines received 160 out of 300 responses, or 53.3%. Other major sources of stress include Module Grades and GPA Values, although Losing Hopes and Ambitions has also had an impact on students'

Table 3-Common Sources of Academic Stress

Common Sources of Stress in Academic Stress		
Stress Factors	N	%
Module Grades	119	39.9
GPA Values	143	47.7
Assignments on-time submissions	209	69.7
Project Deadlines	160	53.3
Lack of Language Fluency	59	19.7
Difficulty in Balancing extra-curricular activities	49	16.3
Family Problems	43	14.3
Financial Problems	55	18.3
Isolation from parents	25	8.3
Health-related problems (Ex-Migran)	56	18.7
Personal relationship matters	51	17
No faith	44	14.7
Loss of Hopes and ambitions	86	28.7
Other	23	7.7

The below table shows the average and percentage values of positive and negative responses received by the survey respondents regarding the features of the proposed system.

Table 3-Features proposed for the system by survey respondents

Stress Reduction Features of the System	Evaluated Criteria (Positive and Negative) Responses	N	(%)	Avg
Meditation Guidance	Positive	278	92.6	0.92
	Negative	22	7.3	0.07
Yoga and Relaxation Exercise Guidance	Positive	272	90.6	0.90
	Negative	28	9.3	0.09
Calming and Relaxation Music Player	Positive	283	94.3	0.94
	Negative	17	5.6	0.05
Mind Maps	Positive	270	90	0.09
	Negative	30	10	0.1
Assignment due Date Reminder	Positive	258	86	0.86
	Negative	42	14	0.14
Academic Reminder	Positive	271	90.3	0.90
	Negative	29	9.6	0.09
Digital Notebook to keep records of your Daily Life	Positive	257	85.6	0.85
	Negative	43	14.3	0.14
Workload Organizer	Positive	272	90.6	0.90
	Negative	28	9.3	0.09
Gaming Component	Positive	203	67.6	0.67
	Negative	97	32.3	0.32
Selfcare Reminder	Positive	273	91	0.91
	Negative	27	9	0.9
Community Forms to Communicate with Others	Positive	248	82.6	0.82
	Negative	52	17.3	0.17
Motivational Video Clips	Positive	263	87.6	0.87
	Negative	37	12.3	0.12
Ultra-Hypnosis	Positive	227	75.6	0.75
	Negative	73	24.3	0.24
Time Tracker	Positive	262	87.3	0.87
	Negative	38	12.6	0.12
Audio and Art Therapy	Positive	240	80	0.80
	Negative	60	20	0.20

As per the finding from the survey, there is a high number of positive responses for Meditation Guidance, Yoga and Relaxation Exercise Guidance, Calming and relaxation music players, Academic reminders and many more.

The below table shows the personal stress coping strategies used by university students. Out of all the 300 responses received from the survey majority of the university students' coping mechanisms used to manage academic stress are listening to music, watching videos, being motivated, working hard, and wishful positive thinking.

Table 4-Personal Coping up Strategies

University Students Academic Stress Personal Coping Up Strategies		
Strategy	*Number of Respondents*	*Percentage Value (%)*
Focus on solving the problems causing stress	102	34.4
Seeking emotional Support and Guidance from Someone	94	31.3
Be motivated and Work Harder	154	51.3
Wishful Positive Thinking	144	4.8
Seek spiritual Support (ex: - Pray)	54	18
Meditation	65	21.7
Doing exercises yoga or some other physical activity	59	19.7
Learning new Skills	76	25.3
Avoidance/Ignoring the problem	72	24
Worry over the problems	33	11
Self-Blame	39	13
Tension Reduction by doing something else (Ex-: drinking, Smoking)	22	7.3
Listening to Music	206	68.7
Watching Videos	163	54.3
Using social media	180	60
Online Gaming	57	19
Other	25	8.3

5. Conclusion

Academic stress has the potential to negatively impact a student's mental health, academic performance, and overall well-being. The main sources of stress are academic-related concerns including Assignments on-time submission, GPA Values, Modular Grades, and Loss of Hopes and Ambitions. The personal coping mechanisms used by university students to manage academic stress are listening to music, watching videos, being motivated, and working hard, and wishful positive thinking. Moreover, it shows that there is a significant relationship between the ability to manage stress levels and gender, academic year, or university type of undergraduate students.

6. Future Work

In terms of future work, this proposed System is expected to be developed and implemented. Finally, it is intended to develop a comprehensive desktop program for university students to interact with the system in a pleasant and user-friendly manner while working on their academic work.

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Voice Command and Face Motion based Activated Web Browser for Differently Abled People

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Abstract: There are numerous people who are unable to use their hands due to a disability from birth or external factors like accidents. There are many military personnel who also have lost their arms and hands because of bombing and shootouts from the war in the country. These people require further assistance from another person to access the Internet. They are embarrassed because they cannot do it independently. They might hesitate to seek assistance constantly. This also raises the issue of their privacy. But because of technological advancement, now people who are disabled can do their work very easily. There are many developed applications with the voice command ability to search or type something. The main difference between those applications and the proposed system is it has the ability to use voice commands to control and use face detection to control the mouse cursor in the same application. Differently abled and handless people can use this web browser to do their work as a normal person. This proposed browser may use a voice command to control the mouse cursor and it can use voice to text to type URL. Further, computer vision may use to control the mouse cursor. This web browser can use to ease the work of normal people as well as used by disabled personnel. Both the voice command module and the web browser module were created using python. Additionally, the python Application Development Kit was used to develop the front end and back end. The researcher used open-cv to create the cursor control module. Numerous libraries have been used in the system's development. PyQT5 and QtWebEngine were both used in the development of the web browser application module. Google Speech Recognition engine API and PytTsx3 were both utilized in the development of the voice command module. OpenCV-Python-cv2, Numphy, Dilib, and autopy were used in the creation of the cursor control module.

Keywords: Face Detection, Speech Recognition, Assistive Technology

1. Introduction

Voice is a very natural way to interact with a computer or device. It is still a struggle for technology in our culture, and as time goes on, we see more items and technology that can be operated by voice. Human-machine scenarios, such as those involving elderly or physically disabled people who do not have free hands to type in commands, could benefit from allowing users to command their devices or systems via voice. This would give users more control over how their devices is controlled than they could get from having someone else do it for them.

It is the goal of voice control to enable persons with special needs or those who want a luxurious and sophisticated house with a system that can understand what they say, respond to voice commands and control in real time, and achieve a hands-free computer interface[1]

When it comes to the use of face detection control over the proposed web browser it can be used to control the mouse cursor by using face coordinates gotten by the webcam. This system frees the subject from having to wear a controller to move the cursor on a computer. The subject's facial expression is recorded via the web camera, which is connected to the computer. The PC sends information about the X-Y coordinates of the cursor location while continually tracking the movement of face points. A voice browser (hardware or software) generates voice output, analyses voice input and may take and produce additional modalities of input and output, such as text input and output using vocal markup languages. Currently, voice browsers are used primarily to allow visually impaired people to speak and listen to information available on the internet via a phone, mobile phone, or any other device, hence increasing the accessibility of web-based services.

Voice browsers create synthetic speech or playback prerecorded speech as output using spoken words as input, depending on the kind of browser. There are a wide variety of hardware devices where voice browsers can be used, including telephones or cell phones; handheld computers; palm-sized computers; laptop and desktop computers; and televisions; radios; VCRS (voice-activated control systems); remote controls; ovens; coffee pots; and doorbells. In the real world, a voice browser is essential for gaining access to both public and confidential information, as well as for facilitating voice-mail communication. Currently, users interact with voice browsers only using telephones and mobile phones. Other modes and media, including pen, video, sensor, and graphical animatic and actuator controls, may potentially be supported by voice browsers in the future. If a user is functionally blind or needs online access, they can utilize voice browsers and voice controllers to display an unseen user interface to the

user while keeping their hands and eyes free for other tasks, thereby freeing up space previously taken by keyboards and mouse.

"Devices which interpret (voice) markup languages and are able to generate voice output and/or interpret speech input" are known as "voice browsers." A general definition of a voice browser is provided above. Given that "browser" appears first in its name, it is clear that the system handles speech. However, what makes it a "browser"? When it comes to either domain data or dialog flow, the system relies on information from the internet. The goal is to provide a service comparable to what graphical browsers of HTML and associated technologies do today, but on devices that do not have full browsers or even displays large enough to handle them. The problem is made worse by the fact that a lot of today's content relies on the correct functioning of scripting languages and third-party plug-ins.

Machines and programs with voice control can take dictation or recognize and execute spoken commands. A computer system may also be controlled by a voice or a series of voices that the computer has been trained to recognize. The structure of this paper is as follows, initially reviewed the literature on assistive technologies that have been used to prevent the uneasiness of differently abled personals. Then conducted the survey to study the background of differently abled handless people and how they use the current system to browse the internet. Then identified the research gap. The Voice Command and Face Motion-based Activated Web Browser have been proposed as the solution.

The proposed web browser can be used by differently abled handless people who are unable to operate the current web browsers. The proposed web browser will be able to operate through voice commands and move the mouse cursor using face motion. The Objectives of the proposed web browser are identifying the problems faced by differently abled handless people when browsing internet. When developing the proposed web browser identify the relevant technology to establish the functional and non-functional requirements are important. Most crucial factor is in this research design and develop the voice and face detection-based web browser that could be used by differently abled persons. Finally the proposed system should test and it should evaluate. The present work aims to introduce a web browser that could be operate by differently able handless people using their voice and face detection to give command and control the cursor. The goal of this research is to learn about the limitations, obstacles, and maturity level of voice control and voice browsers, and how speech recognition may be enhanced to make opportunities more accessible to those with physical disabilities and to those who desire a luxurious lifestyle. How voice prompts can be used to control digital devices is also discussed, as well as suggestions for how to make voice accessibility even better. However, it is more about how those who are physically disadvantaged may adapt to new technology that are already or will be a part of their daily lives[2]

Furthermore, the possible solutions to these limitations, such as restricting users to specific commands and how to deal with the difficulties posed by cultural (and time zone) and linguistic diversification, are also discussed. People from various ethnic groups and nations may have difficulty with the same voice command, which is often an English term, because of the variances in their pronunciation. Also explored are prospective future uses for voice control and voice browsers, as well as how we can use this technology on a day-to-day basis soon.

2. Literature Review
A. History of Voice control and Voice browsers.

In 1936, AT&T's Bells laboratories began studying automated voice recognition and transcription. It was not until the early 1980s that the technology became available to the public, financed mostly by the military and DARPA the Defense Advanced Research Project Agency.

When Covox launched its first commercial product in 1982, it was the first firm to do so. In the 1980s, Covox introduced digital sound to the Commodore 64, Atari 400/8, and IBM PC with the voice master, sound master, and speech thing. Speech recognition was introduced together with (or as part of) the introduction of sound to the computer. It is also worth noting that Dragon Systems was created in 1982 and has gone on to dominate the voice recognition market with their software. ScanSoft, Inc.

For many years, Audrey was a speech-recognition system built by Bell Labs. It was a simple system that only recognized the first nine digits of the alphabet. It also necessitated a pause between each syllable, making it difficult to utilize. IBM's "shoebox" gadget, introduced in the early 1960s, could understand 16 complete phrases, including 10 numbers and 6 arithmetical commands. Both Audrey and Shoebox were, of course, quite impractical by today's standards because they could not be easily transported[3]

In the 1970s, the Department of Defense became interested in voice recognition and contributed some funds for research, which sparked the development of Harpy. The "Harpy" system, developed at Carnegie Melon shortly, thereafter, had a vocabulary roughly equivalent to that of a child, with a substantial increase over earlier systems. Speakers still had to stop between words so that the computer could identify them, which meant that this technology was severely constrained in terms of more than just vocabulary. Speech recognition truly took off after Harpy when the hidden Markov model (HMM) was introduced, which would later be used by IBM, Philips, and Dragon systems to build their voice recognition systems. To expand the vocabulary of a voice recognition system, HMM enables systems to take into consideration the

potential that unfamiliar sounds may constitute words. For example, the Julie Doll by worlds of wonders "The doll that knows you" made it feasible for voice recognition technology to find commercial uses. Dragon was born in the 1990s when computers grew in popularity and processing power exploded, making computers a viable commodity.

It was the first consumer voice recognition system to be sold for more than $900, and it was called Dragon Dictation. With Dragon Naturally Speaking (DNS) in 1997, you no longer must stop and think about what you are saying before continuing. Still $645 and requiring a lot of time for the consumer to learn, despite a price reduction.

After the creation of Dragon, Siri saw that things had slowed down a bit. Though a few people were aware of the feature, both Vista and Mac OS X featured voice recognition incorporated into the operating systems.[2]

To put it another way, voice recognition was going to be one of those novelty technologies that never found its place in the mainstream. Then, in 2007, "Speakeasy" was introduced. As a follow-up, Google voice search was launched for the iPhone in 2008. In addition to the mobile interface being great for voice recognition, as we had discovered the year before with "Speakeasy," the app had access to more computational power than ever before by shifting the data processing essential for speech recognition to Google's cloud data centres.

New personalization features were implemented in 2010, allowing the program to learn from you and become more accurate than ever before in 2011, "Siri" was debuted, and it rapidly became a sensation. For better transcription accuracy, it makes advantage of cloud-based processing, as well as artificial intelligence and personality. There's little doubt that speech recognition has reached the public, despite a fall in usage after the novelty wore off.

B. History of face detection

Woody Bledsoe, Helen Chan Wolf, and Charles Bisson were among the first pioneers of face recognition. Bledsoe, Wolf, and Bisson started working on computer-based facial recognition in 1964 and 1965.Much of their work was never released since the research was sponsored by an unnamed intelligence agency. But it was later discovered that their early effort involved physically marking different facial "landmarks" like the mouth and the centres of the eyes. To compensate for pose variation, these were then mathematically rotated by a computer. In order to identify landmarks, the distances between them were also automatically calculated and compared across images[4]

These early experiments in facial recognition by Bledsoe, Wolf, and Bisson were greatly limited by the technology of the time, but they still represent a significant first step in demonstrating the feasibility of facial recognition as a biometric.

Following up on Bledsoe's original research, Goldstein, Harmon, and Lesk continued the study in the 1970s and expanded it to include 21 distinct subjective markers, including hair colour and lip thickness, in order to automate recognition. Even though the precision was improved, the measurements and positions had to be calculated manually, which proved to be incredibly labour-intensive but still a development over Bledsoe's RAND Tablet technology.

The Facial Recognition Grand Challenge (FRGC), which was established in 2006, has as its main objective the development and advancement of face recognition technology intended to assist ongoing face recognition initiatives within the U.S. Government.

The most recent facial recognition algorithms were assessed by the FRGC. The experiments made use of high-resolution facial pictures, 3D face scans, and iris photos. The results demonstrated the improvements in facial recognition technology over the previous ten years, with the new algorithms being 10 times more accurate than face recognition algorithms from 2002 and 100 times more accurate than those from 1995.

Social media started adopting facial recognition technology in 2010 to assist in identifying persons whose faces could appear in the pictures that users upload on a regular basis. The news media immediately found the feature to be contentious, which led to a flurry of pieces on privacy

C. Uses of Voice control and Voice browsers

Voice control is an option for customers that require quick access to basic information. A live operator may not be necessary or desired in many situations. Speech recognition, for example, can be used to shorten wait times and offer consumers with the information they need if they only have a limited amount of time or information needs. An intelligent speech system allowed Dublin Airport to handle a 30% increase in passenger traffic without increasing the number of staff members. When a consumer phones in, the system immediately routes them to a voice recognition system, which uses a series of questions to determine whether they need information on "departure" or "arrival."

Phone calls may be routed to the appropriate department using voice commands. Customers may become irritated and dissatisfied if they must wait in a long line to speak to an operator. Using voice recognition, may lead customers to "self-service" options or just "speak" what they need, and the appropriate department or person will be contacted. To confirm someone's identity on the phone, voice commands can be utilized instead of "risky" personal data. Identity fraud is a huge worry for some organizations, and a sophisticated speech recognition system gives a response to this problem utilizing voice biometrics, which is a crucial instrument in preventing telephone-based crime4[5]

When your phone's call volume surges or you need to navigate your Android phone or tablet, you may utilize voice controls to manage the situation. Some voice browsers may be taken on the go. There is no limit to where you may utilize them. More individuals will be able to access information, especially those without networked computers but with access to handsets, such as cell phones

D. *Applications of Voice browser and voice control*

Other applications include teaching students of other languages how to pronounce words correctly and translating across languages, as well as controlling autonomous robots in a multi-robot system via voice control. Appliances like the oven, refrigerator, and dishwashing machine may all be controlled using voice commands.

Vocal control can be used in military aircraft and helicopters as well as in combat management systems for teaching air traffic controllers. Medical transcriptions and health care may both benefit from the use of voice control in the industry (digital speech to text).

E. *Early Improvements*

Text to speech and speech to text technologies were successfully merged and used as a communication channel between two physically challenged people in this Speech Recognition & Synthesis Tool. System. To turn spoken words into text, a Speech. Recognition engine is employed. The W3C standard for voice recognition is supported by SAPI 5.3. The SRGS markup language, which specifies how and what words are recognized by the engine, is also supported[6][7]

Using speech recognition technology to complete the university's written proficiency exam proved to be a beneficial trial at California State University in Northridge. They were able to obtain an equal distribution of exam marks with their nondisabled counterparts thanks to this innovation[8]

A sixth-grade kid with learning impairments was the only focus of another exploratory investigation. For Wetzel, the goal was to see if middle school children could learn to utilize a speech recognition system, such as IBM Voice Type, and whether this technology would help them improve their communication abilities. Although Wetzel observed that the student was able to grasp the program, challenges with the system's recognition accuracy and the intricacy of editing hampered this student's performance[9]

The Frostig Center for Learning Disabilities in Pasadena, California, researcher Marshall Raskind revealed that speech recognition software might make a significant impact for many dyslexics. Speech recognition can help dyslexics speak more effectively, but it may also help them overcome their disease, according to a new study[10]

A voice-activated browser and screen reader are included in a specialized small web browser. According to the GNU General Public License, the website browser is a free software project. Using the text-to-speech engine, the new built-in screen reader may now be enabled by just hovering the mouse pointer over it. In addition to the spoken command input, the browser now has a dialog module. Web page navigation is possible with this tool. To utilize the new online site, which is reserved for blind and visually impaired people alone, the Developed Browser has been designed specifically. It is expected that all sites on this portal and those connected to it will conform to the Web Access Initiative's fundamental standards for HTML/XML pages[11]

A cloud-based wheelchair platform that controls prototype speech is described in this article. Cloud-based speech WebKit is under the control of the platform. It also works on online browsers and mobile devices that broadcast live video, in addition to voice control. The Arduino UNO Microcontroller and the Mini PC running Ubuntu Linux constitute the foundation of the platform. JavaScript and ECMAScript were used to construct the software[12] Drowsiness may be detected in real time according to the system's architecture. The program is written in C++ and runs on Windows utilizing the OpenCV library and a single camera view. Under ideal lighting circumstances, the video surveillance system technologies they described offer promising outcomes[12]

In many circumstances, people with neuro-Locomotor difficulties are able to comprehend and should communicate through their eyes. Eye-tracking mouse-based system is provided in this study, which is both scalable and cost-effective. When the user's eyes move, a headmounted device picks up the movement and moves the mouse pointer on the screen. If the patient gazes at the relevant picture on the screen for a predetermined amount of time, a click event signifying a pictogram selection is executed[11]

3. Proposed Methodology

There are many military personnel who also have lost their arms and hands because of bombing and shoot outs from the war in the country. These personnel need the help of another person to access the Internet. They are embarrassed because they cannot do it independently. They may feel uneasy to always get help. This also raises the issue of their privacy. But because of the technological advancement, now people who are disable they can do their works very easily.

Due to various reasons, there are many people who are with disabilities, and they should totally rely on others to access the Internet. So now there are already developed applications with voice command ability to search or type something. But there is no customized web browser

developed for differently abled and handless people. In order to address this issue, The researcher proposed a web browser that can use without hands. differently abled and handless people can use this web browser to do their works as a normal person.

As a methodology for conducting this research first studied literature that considers assistive technologies that has used to prevent uneasiness of differently abled personals. Then conducted the survey to study the background of differently abled handless people. Then researcher has identified the research gap.

According to the literature survey above conducted it is evident that control a web browser for differently abled and handless people is much needed implementation since only few research has been done targeting some few parts of it. Up to now in the research that was conducted under domain specific that have covered following domain
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i. physically disability services
ii. improve assistive technology for learning disability
iii. Voice driven and speech recognize
iv. Detecting eye movement by computer vision

Specifically, the problem identified in this scope is use the internet by differently abled handless people. Above research have covered some parts in this problem domain but there is no specific solution for this problem. Below table shows the comparison of above research and proposed system.

Table 1. Comparison of the existing system and the proposed system

Research	Web browsing application for differently abled people	Computer vision -based solution	Voice driven solution	Integration of modules to specify the problem identified
(Sharma and Wasson, 2012) [8]	No	No	Yes	No
(Higgins and Zvi, 1995) [10]	No	No	Yes	No
[11] [11]	Yes	No	Yes	No
(Dhaval Pimplaskar Atul Borkar, 2013) [13]	No	Yes	No	No
Proposed system	Yes	Yes	Yes	Yes

According to the conducted survey 14 personals have answered to the questioner that who cannot use both hands and disabilities in their hands. According to the survey 78.6% of differently abled handless people are like to use internet like other normal people.71.4% has feel uneasy when they are using internet by assistant of a third-party person.78.6% people is needing a new solution that they can use internet without the help of a third party.

A. Approach

In the Analysis of the Voice command and face detection-based web browser people can use the web browser for browse the internet by only using voice commands and face detection to control the cursor. User can type URL on the URL bar in the web browser by speaking though the microphone and turn spoken words into text, and the user can type the specific URL of the web site that user needs to browse. When it comes to the search functions in the search engines user also can use the voice to text feature in the proposed browser. Use can use the other functions in the web browser by giving voice commands. When user need to open a tab, close the current tab, go backward through web pages, go forward through web pages, refresh the current web page can use necessary voice commands featured in the proposed web browser. Apart from the voice command one of the main functions in this web browser is the user can control the mouse cursor by using face detection and user can move the mouse cursor by moving the face. In the mouse scrolling, clicking function can use by using the voice commands.
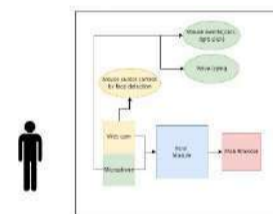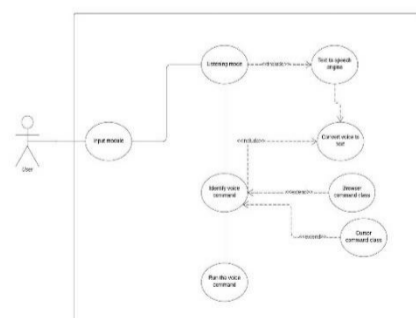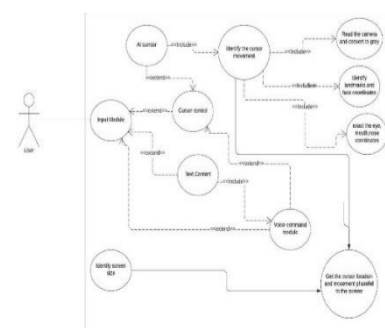

Figure 1 Block diagram of the system

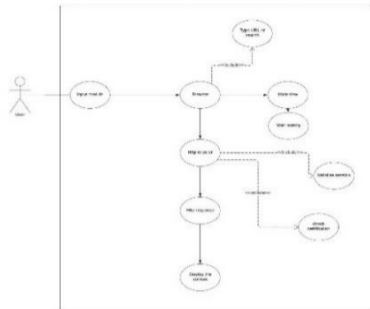Figure 2 Use Cases Diagrams Cursor control module

Figure 4 Use Cases Diagrams web browser
module

B. Technology Adopted

The system should use the newer technological methodologies. It is important to use necessary tools.in order to create a productive system. Use of any inappropriate Technologies may only result in the development of a system having errors and faults. Badly chosen technologies additionally can end 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 developing a system that spends lots of time and resources to perform a task that is anticipated by the system. The most important goal of creating this kind of application is to give consumers a more efficient work system. Technologies and tools can assist to develop the system with a minimum amount of time. Because of that, should use the most applicable tools available 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 proposed voice command and face detection-based web browser python has used to develop the web browser module as well as the voice command module. The programming language that will be used to build the system, acquired the trust, accuracy, and efficiency. When considering all these technologies which can be associated with the proposed system can be applied python application building tool. As well as the front-end back end also developed with the python application development kit. To develop the cursor control module researcher has used open-cv. There are many libraries have used to build the system. To develop the web browser application module PyQT5 has used and as the web engine QtWebEngine has used. To develop the voice command

module PyWhatKit, PytTsx3 and google Speech recognition engine API has used. To develop the cursor control module OpenCv-Python-cv2, Numphy ,Dilib and autopy has us

When discuss about the functional requirement proposed web browser can control the cursor with the face movement. In order to type an URL or search on a search engine, proposed web browser can use voice to text to enter URL and Search in internet. Proposed web browser can use voice command to control the web browser events such as clicking and scrolling events in browser functions.

When discuss about the nonfunctional requirement proposed web browser the Efficiency is one of important attribute the proposed web browser performance take minimum 512RAM and disk Space - minimum 1GB. When discuss about the Security, differently abled handless people should be able to browse internet without the support of third party and the interoperability of the web browser should be able to use in different kind of operating systems. When talk about the usability of the proposed system the web browser should be able to use easily perform task, effectively, and efficiently while enjoying the experience.

4. Discussion

The results and outcomes engendered in relative to the specificity of the problem domain are enlarged into wider concepts depending on logical assumptions. the outcomes and findings of the project and to determine the way of these outcomes and findings can be matched in different contexts that are like the problems which are solved by the developed voice command and face detection-based web browser. The research problem identified in this research is People who are differently abled and handless that cannot control the mouse and keyboard must face many difficulties when browsing the internet. They face many difficulties such as inability to type a URL, using the search, browsing social media, etc. It is necessary for another person's help when doing these tasks. This may result in privacy issues since confidential passwords and user data may be needed to be shared with third parties. There is also the issue of inability to access the internet at their own leisure since they have to wait on a third party being present in the location. According to the literature review and the survey research gap has identified. The studies mentioned above literature review covered some parts in this problem domain but there is no specific solution for this problem. To fill the research gap proposed solution has developed accordingly. In this proposed browser using voice command to control the mouse cursor events and it can use voice to text to type URL. In further computer vision use to control the mouse cursor and users can move the cursor by using face movements. This is an interim presentation of an

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ongoing research and no experiments or implementations conducted.

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Online Platform for Pre - School Management

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Abstract: *This study's primary goal is to examine three potential options for enhancing pre-school learning and instruction. After that, the report will provide a recommendation for the best course of action to take to address the research questions. Information and communications technology (ICT) in pre-schools will be examined as part of this study as well. But it will address the benefits and drawbacks of a web-based electronic learning system in comparison to a conventional educational system for children.*

Key Words: *Childhood, Education, Web-based, E-learning, Pre-school*

1. Introduction

Design and create a web-based application that focuses on utilising real-world items to promote pre-school learning of the English alphabets and number counting and achieves a more precise activity base-learning. The goal of this project is to do literature research on user-centered design as well as the current teaching and learning trend, considering the strengths and shortcomings of each. It is important to create and construct a simple, but advanced, web-based application that is geared toward teaching youngsters rather than causing devastation. To create a system that helps children concentrate and enjoy learning by using real-world elements such as music and pictures that grab their attention. To increase the effectiveness of pre-school teaching and learning while also increasing the rate at which developing children learn. This system should be confined to pre-school activities, but not higher levels of performance, and it should explain the critical areas of children's growth and learning abilities.

A. Problem statement

The following issues will be addressed by this research based on prior studies and investigations of the existing system of education for children: Parents and instructors will have a tough time monitoring their children's growth and performance since most of the current system does not enable kid assessments. Most of these websites are exposed to external connections for advertising reasons to generate additional revenue for some of the website owners that provide these online educational resources for children. This might have an adverse effect on the children if they navigate away to some of the harmful material.

As an example, consider recordings with explicit sexual material or those showing acts of violence. iPads and iPods may not be able to view lessons because of the reliance on SWF file types. It is well-known that the Mac OS X operating system does not presently allow flash material, which means that many children whose parents use Apple computers will not be able to view these classes. There are hazards and challenges linked with inadequate information supply, such as classes that do not align with the curriculum of what students are studying in their schools.

2. Literature Review

Effective education is critical to a nation's social, political, and economic success, according to this view. To assist students, go from one learning level to the next in a more social and interactive setting, teachers must be effective. They must also employ the correct strategy to help students become self-directed learners. Formal education in the US is heavily subsidized by the federal and state governments, according to Edward, Walter, and Stephanie (2012). They begin public education for children at a

young age. Most cities allow children as young as five to begin attending the public school system. Public schools in New York City and Boston, for example, accept children as young as four years old and as young as 22 months old. This illustrates that preschool programs are a high point of many educational and social changes, and that early childhood education is widely becoming the most effective strategy to increase children's scholastic achievement. Sending a child to preschool will help him or her be more prepared for elementary school and other forms of formal education. There are a variety of factors that will impact whether or not a student is more likely to succeed in school and later in life. The need of educating children so that they do not fall behind in today's competitive digital world cannot be overstated. Preschool instruction, according to research, helps youngsters enter kindergarten with more developed learning abilities. A child's learning talents are polished and ready for kindergarten if he or she is read to regularly at home, attends museums, has online learning or training available, and learns how to play a game (Stube & Patrick, 2010). Children's intellectual, physical, artistic, social, and emotional development may all be facilitated via play, according to Johnston et al. (2010). Practitioners may help young children learn while having fun and being challenged by offering well-planned indoor and outdoor experiences based on children's natural play. The concept of playing

appeals to children. Better learning would be achieved in a world full of various play activities. That is why it is a good idea to engage youngsters with activities that are both entertaining and interesting. There will be a lot of language used, and the kids will not know they are learning certain letters, words, and ideas as a result. BBC News (2008) reports that some study has shown that computer systems or web-based preschool systems may be utilized to deliver interactive educational activities to children that will help them to recognize or differentiate shapes while also awarding them a score simultaneously or at the end.

Teachers and instructors may also use web-based or computer systems to get their students to listen to tales by showing them pictures and videos along with the text. The Development of Expressive, Creative, and Aesthetic Skills (ECAD). Children are at the pre- operational stage throughout the preschool years, according to Morrison (2009). For the duration of this period, youngsters will base their judgements mostly on how things seem, believing that everyone else believes the same thing they do. Children are heavily impacted by their views at this pre-operational stage and do not completely grasp the notion of dialogue. Children who struggle with conservation have a hard time grasping the concept that despite physical changes, the amount of something may remain the same. Another example would be showing a youngster two similar cups each filled with the same quantity of rice and having them try to guess which one is which. into two different-sized cups, a youngster will believe that one cup has more rice than the other, even though there is the same amount of rice in each cup.

It is critical to keep in mind things like the child's sensory needs. Placing study resources like charts and drawings in conspicuous settings, for example, may help students learn better via their sense of sight. Other senses, such as touch, smell, and hearing, are also important for appropriate learning and must be taken into account. If the senses are properly treated, learning becomes simpler for such children (Barbarin & Wasik, 2009). Using a web-based approach, researchers have conclusively shown that play is critical to a child's development in a variety of ways, according to Bracken and Nagle (2007). Kids' play has been shown to boost desired cognitive abilities like problem solving, critical thinking, and creativity, as well as spoken and written language. It may even help develop modest managerial skills like organization and planning in young children. As a rule, it leads to a child's achievement in both academics and extracurricular activities. Using web- based programs that develop reading and writing cultures, Deidre Crook (Online, 2007) found that young children can use paint programs with the help of web-based computer systems. They were also showing their peers how to use the programs and helping the development of language and literacy.

A. Preschool education with the use of information and communication technologies (ICTs)

Children learn via play and discovery from the time they are born until they are eight years old. According to recent research, using technology in the classroom enhances student learning in a variety of ways. [source] The following are only a few examples of the impact:

•   Young children are motivated to study, and their cognitive and social development is aided by the use of web-based or computer-based resources in the classroom.

•   Children's self-concept and learning attitudes are improved when they utilize a web-based or computer based system

•   When using a web-based or computer system, children tend to communicate and cooperate more verbally. Web-based or computer-based play also promotes the development of fluency and more complicated speech.

•   Kids are more likely to engage in turn-taking while using a web-based system, which means they are more likely to utilize a computer when it is their time. Children learn to explain what they do while drawing and colouring drawings or moving items and characters around the screen using a web- based computer system. To have a beneficial influence on children's learning, web-based computer systems or technology should only be used for 10-20 minutes at a time, since youngsters become bored rapidly and like trying new things.

B. Preschool e-learning has several advantages over conventional children's education.

It is used to make choices regarding children's learning development, as well as to boost children's learning and motivation. Rapidity: Because it is a global phenomenon, the rate at which it spreads is unfathomable. Computer platform independent: It may be completed using a computer, a smart phone, or other electronic device. Learning space: It encompasses a broader variety of learning opportunities with no upper limit. Learning may be conducted at any time of day or night since toddlers can learn and read things even when it is dark outside their classrooms.

•   It is used to keep track of how well children are doing.

•   It is an excellent chance to save money: it is possible to save money by not hiring a private teacher, which is both cost efficient and saves money.

Because preschoolers do not have to leave their homes to attend the class, it is even more secure.

C. Disadvantages of preschool vs regular children's education

- Internet: It is possible that a continuous supply of internet connection will be required.

- Power: To work properly, it needs a steady supply of electricity.

- Time: Because of the addition of it, it is a time- consuming process.

D. Summary

Even though it is not often accepted, most nations feel that web-based computer systems or technology may be used to supplement traditional ways of educating young learners, but this is not widely acknowledged. When it comes to learning and understanding their surroundings, children may benefit from utilizing a web-based computer system, but it should never be used in lieu of real-world materials and manipulatives in a classroom setting. Students' cognitive, social, and emotional capacities are all improved because of using a web-based preschool system. It is vital for children's future success in the increasingly competitive world of the information age that they have a quality preschool experience. It is possible that information and communication technology (ICT) will aid in the educational development of children by improving the flow of Preschool. When it comes to educational technology, a

web-based preschool system is a welcome addition since it makes use of information technology to assist children in improving their learning skills and academic performance. At the same time, it will alter their way of thinking and expose them to a variety of ideas and cultures. These reforms are being implemented to address problems in children's education as well as present educational structures.

3. Research Design and Methodology

This chapter will outline the research questions and study design that will be used in the investigation. It will also contain information on how data will be obtained, who will be providing the data, and how the data will be assessed. In this study, data will be gathered via the use of qualitative and quantitative research methodologies, as well as the Prototype System Development Model, among other approaches.

A. Research Questions

Members of a focus group or the target audience were asked to participate in surveys, observations, and one-on-one interviews as part of this study, which aimed to fill in any knowledge gaps identified in the existing literature. Specifically, we undertook this study to answer three specific research issues that arose from the review of the literature.

1) To begin, what are the current teaching and learning obstacles that preschool programs are facing, and

what can be done to solve these concerns, are described below.

2) The following are two more questions: "First, is information and communication technology (ICT) the future of early childhood education, and if so, what consequences may it have on the creation of preschool curriculum and programs?"

Finally, what function does information and communication technology (ICT) have in the evaluation and learning process throughout the preschool years is discussed.

B. Research Design

During this phase, the research subjects and difficulties are defined and outlined in depth, including the structure, processes, and strategies that will be used to address them. An in-depth understanding of the major research techniques is shown in Figure 1 below.
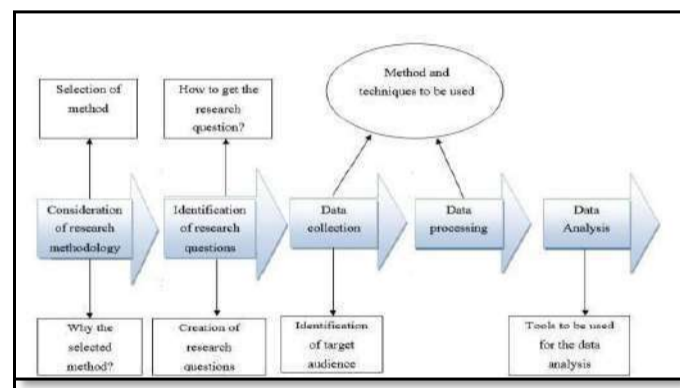

Figure 1 Research techniques

C. Data Collection

The data for this research will be gathered via interviews, observations, and surveys, with each of the three key target groups being interviewed separately.

D. Target Audience

Because this research focuses on preschool and early childhood development, it will be directed towards the following audience, which will give significant data for future analysis. When it comes to addressing the research questions, the depth of information acquired will be beneficial. Specifically, his research is aimed at the following demographic:

- Preschool instructors/trainers, as well as anybody in a position of authority, are encouraged to participate.

- The guardians and parents of preschoolers Children enrolled in preschool or academics

E. Prototyping Model

To construct this system utilizing a prototype, there are three key reasons for doing so. Listed below are their given names:

1) With this method, it will be feasible to get user requirements from the beginning of the system development process all the way through to acceptance of the final product.

2) It takes longer to build a completed system using this technique since users' requirements change so often, but the result is a better system that users are happier with because the system specification is based on their wants.

3) Because a prototype will be provided to users after requirements have been acquired from them at the beginning of the project, this method will help consumers get a better understanding of system development and design.

4. Results and Discussion

The result of the interview based on the findings of the interview

1) Examples include the fact that the institute's current kid-learning system is out of date, leading in longer teaching procedures and more paper errors. Furthermore, the institute's methodology is substandard, and it takes an excessive amount of time to finish duties.

2) Several data errors and vulnerabilities have been discovered in the institute's outmoded database system, which is responsible for managing the learning process.

A. Questionnaires and Survey

This questionnaire was geared towards two different categories of audience:

1) The Parents/Guardians category and,
2) Teachers/ Trainers category

B. The Parents/Guardians category

This category targeted parent and guardian of any kid between the ages 3-6. 75 copies of the questionnaires were distributed to the audience both in hard and soft copies. Outcome of the survey

3) The (figures 2) below shows that 77% of the respondents participated in the survey while 23% did not participate due to their ineligibility.

Fig. 2. Outcomes of parents /kids

4) Participants might use a touchscreen or a pointing device to express their thoughts about the learning abilities of their children based on the assertions in the table. Only 4% of participants disagreed with the statement that ICT is the future of early childhood education. Thirteen percent of those polled were adamant that their child could learn more quickly if they used a mobile device. When asked which method they preferred, 4 percent said they firmly agreed that their children could start and end activities using a touch-screen gadget, while 9 percent said they strongly agreed with the latter. Thirty percent of parents strongly agreed that their children prefer activities that incorporate the use of sounds and rhymes, whereas four percent strongly disagreed with this statement. Threequarters of respondents strongly agree or disagree strongly with the statement "their kids prefer touch-screen device to pointer gadget."

C. Teachers/Trainers Category

This category targeted teacher in the preschool and 30 copies of the survey paper were distributed to 20 persons both in hard and soft copies.

Outcome of the survey

70% out of 100% respondents who are preschool teachers participated in the survey, while 30% respondents were not eligible to participate. See figure 3 for details:
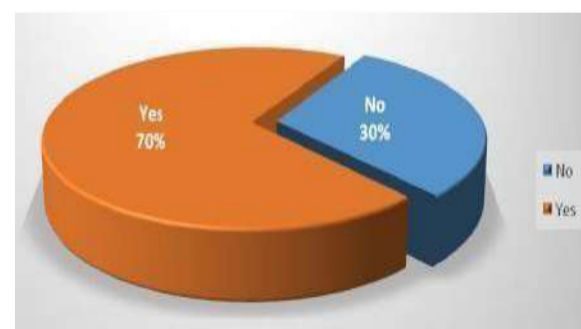

Figure 2 Outcome of Teachers

Observation

The information was gathered at the UCSI-Child Development Center using a procedure that was

450

specifically designed for preschoolers aged 3-6 years. The following is the investigation's primary goal:

• A greater knowledge of the relationships between students and instructors, as well as the learning environment in which they are placed, is sought.

• They want to improve on the skills they have already learned while also learning new ones.

• To have a comprehensive awareness of their shortcomings on all fronts.

Observation Finding

Information about the evaluation technique that each participant used to evaluate the performance of the students was collected from the participants. During their observations of the students and their participation in the classroom with the teacher, the researchers discovered the following characteristics about them: Many kids despise their school's activities. The kind and way the activity is carried out may have a role in this being the case. Singing and jumping are two common hobbies that draw the attention of children and adolescents. They are always on the lookout for ways to learn via play rather than through lectures. Most individuals prefer activities that entail touching and engaging with an object over activities that require speaking. The vast majority of them have already learned the essentials of social interaction. This is a significant advantage. They are just a tiny proportion of the population who have mastered the most basic cognitive, emotional, and environmental talents.

5. Proposed Solution and Justification

According to the feasibility analysis presented above, answer three (a content-based e-learning management system for children) seems to be the most promising solution to the problems with the existing learning management systems. Considering the alternatives, it is unquestionably the most economically and technically feasible solution. As defined by (Roebuck, 2011), a content management system (CMS) is a piece of software that allows non- web programmers to design and maintain the contents of their websites in a simple and efficient manner. Since of this, choosing the best e-learning solution for kids is not a mistake because it is easy to use and generates exciting learning activities for the users. You may use the local-host server (Apache) whether you are online or offline using this strategy if the server is turned on. Despite this, I feel that the best alternative for the e-learning process has been chosen, and that this is the system for managing the material e- learning for children that has been developed.

6. Conclusion

This research proposes that while developing web based instructional tools for schools, a user-centered approach be taken into consideration. The technique was

discussed by three groups of people: teachers, parents, and students themselves. For the approach to be further refined, it is necessary to conduct continuous design, implementation, and evaluation cycles in a variety of educational contexts. There are re-entry points in the process to allow for continuing growth of the process itself. If developers go back to the design phase, they may be able to make adjustments that will improve the learning experience for students. They may go back to the analysis step if they want to re-examine the use context, influencing factors, or learning goals again. The researchers discovered that doing a thorough user-needs analysis and testing prototypes on a regular basis were important to the success of their project. The pedagogical use of Web-based learning tools in educational environments, as well as the repurposing of existing Web-based learning resources.

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How Social Media Affects on Economy?

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Abstract —*It is commonly accepted that social media reduces the productivity of an organization. However, due to the shape of social media changing over time and assisting to evolve new businesses, several studies state that social media is no more an economic killer. The aim of the present study is to review social media's effect on economic growth. For this purpose, it conducted a systematic literature review. After identifying appropriate keywords, it searched five research databases and extracted related articles. The selected articles were summarised considering the article's description of social media and economic relations. Apart from that, it searched the social media usage and inflation statistics of economically default countries to visualise the relationship between the usage of social media over inflation. The literature review found social media positively impacts macroeconomic and small business activities, but negatively impacts national economic growth. Proving the literature outcome, the inflation statistics analysis illustrated a positive relation between social media usage and inflation increase. Then it can state that social media affect economic growth adversely but assist to start economic activities.*

Keywords: *Social Media, Economic Growth, Inflation*

1. Introduction

A. Background

With the industrial revolution which happened in late 1960's the world is began to develop immensely in several aspects. Out of those aspects technology has played a major role in development of world to the concept of "Global Village". In the journey of the above-mentioned development social media was the best opportunity for the people to get connected to each other easily. During past 20 years, social media has become a part of human life-style. Social Media is an internet-based method of communication. People are spending majority of their time online, which offers social media the ability to add value more effectively. Early, social media had a specific user's ability to maintain personal contact, later developed into extremely large data that has practically endless

applications (Cui 2021).Users can share their information, opinions, contents on various social media. And also social media impact on behaviours of humans and it empower vulnerable communities and social media impacts on Geo-politics in both positive and negative manner(Kamruzzaman 2022). Further, the social media became a network where a lot of information is exchanged. Specially, the product promotion can be done via social media platforms to the right consumers. By examining the social media market, companies can target more potential customers, increase regional or domestic GDP, and benefit from social media's everlasting popularity and regular updates.

However, when searching the resources there were two types of arguments. The first one is social media effects on economic growth positively while others to negatively. But there are no direct research to find the relation between social media and economic growth.

B. Aim

Therefore, the present work aims to carry out a review to find out the impact of social media on economy through a literature survey and data analysis.

2. Methodology

It initially figured out the keywords (social media, Economic Growth, Inflation, Revenue generation and GDP) and carried out a systematic literature survey using 6 prominent scientific databases of Elsevier, Google Search, ResearchGate, Taylor Francis, Dovepress, Frontiers. Then considering the relativity of the journal aim and objectives, research title and abstract it selected 18 articles which are mostly suitable to the study (Table 1). However, when study the contents of the paper it found that only 8 research are provided the required information to the study. Then those were evaluated to identify the article's consideration on the connection between economy & social media whether it is positive or negative.

Table 1: Literature survey statistics

Database	No of papers		
	Retrieved	non-related to study	Selected to study

Elsevier	108	102	6
Google Search	183	178	5
ResearchGate	20	15	5
Taylor&Francis	3	1	2
Dovepress	1	1	-
Frontiers	1	1	-
Total	316	298	18

Then it searched the world bank fact sheets on countries and selected 8 countries (Venezuela, Sudan, Lebanon, Syria, Iran, Turkey, Zimbabwe and Argentina) which carries the with highest inflation rate at present. Then it attempted to find the internet and social media usage statistics from the available data source for the selected countries. As the available data are limited to last 10 years, it done only a visual presentation of the relationship between the social media users and inflation.

3. Data and Analysis

A. Literature Survey

Ulusoy (2015) research on impact of social media on small businesses" found that social media includes an increase in awareness and inquiries, enhanced relationships with customers, an increase in the no. of new customers, enhanced ability to reach customers on a global scale and helps to enhance the image of small businesses. Collectively this research depicts that Social media has a positive impact on economic growth.

Anno et al. (2016) have researched on impact of social media on economic growth . It is discovered that an increase in social media penetration has a negative and significant effect on economic growth. In particular, a 1% increase in the number of social media users contributes to a decrease in GDP growth of between 0.02% and 0.06%. so, it has been stated there is a negative impact of social media on economic growth.

Cui (2021) has studied the impact of Social Media on the Economy and discovered that social media has a profound impact on the modern economy and it will continue to influence and make greater contributions to economic growth. The article serves as a reference to understand the current development trend of social media and hopes that more people will pay attention to and correctly use the influence of social media on economic emergence. So, there is a Positive impact.

Vitenu-sackey (2020) has done research on the impact of social media on economic growth. The positive relationship finding supports the first hypothesis of the study as YouTube and Twitter showed positive and significant impact on economic growth. They argued that the abolishment of barriers to entry to enable users of social media to publish and disseminate information without any limitations with the support of proper and efficient internet

and broadband supply then social media could positively affect economic growth. And, the study found that Facebook and Pinterest negatively affect economic growth. It has been found there are both positive and negative impacts of social media on economic growth.

Cheng et al. (2021) has worked on a research to identify the relationship between CSR communication on social media, purchase intention, and E-WOM in the banking sector of an emerging economy. It has been stated as social media with its interactive feature and open-source features has become a prominent place for customers to engage with organizational relationship management including corporate social responsibility. Overall, there is a positive impact of social media on economic growth.

Lupa-Wójcik (2019) work identifies the role of social media in economy with selected issues in microeconomic consideration. It has been stated that social media allows to optimize operating costs and enable more efficient use of resources. They also have a real impact on consumer decisions. Thanks to the case study method, it was possible to show the significant role of social media in the economy in a microeconomic perspective. Collectively there is a positive impact.

Permatasari's (2018) research, "The Impact of Social Media on Consumers' Purchase Intention A Study of Ecommerce Sites in Jakarta, Indonesia" says social media dependence has a significant impact on perceived value, in which a higher usage of social media may have led to a higher perceived value for consumers. As a summary there is a positive impact.

Ne et al. (2019) have done an empirical study on African countries to find the social media affect economic growth. he results indicate that social media negatively affects economic growth. However, the impact of these media on economic growth is not direct and passes through the labour productivity channel. According to the study labour productivity was the determinant of economic growth and found that productivity is likely to be affected by the use of social media. Collectively it says there is a negative impact of social media on economic growth.

Table 2: Summary of positive and negative effect of social media on economy

Publication	Impact		Description
	+ve	-ve	
Ulusoy (2015)	x		For small businesses
Anno et al. (2016)		x	1% increase of social media users decreases GDP by 0.02-0.06%
(Cui 2021)	x		Business can understand the market dynamics
Vitenu-sackey (2020)	x	x	Facebook and Twitter positively while YouTube and Pinterest negatively
Cheng et al. (2021)	x		Assist to corporate social responsibility in organizational relationship management

2

Lupa-Wójcik (2019)	x		Optimize operating costs through efficient use of resources.
Permatasari (2018)	x		higher perceived value for consumers
Ne et al. (2019)		x	Effect on labor productivity

B. Social Media Data Analysis

The relationship of the inflation and social media users are shown in Figure 1 to Figure 8.
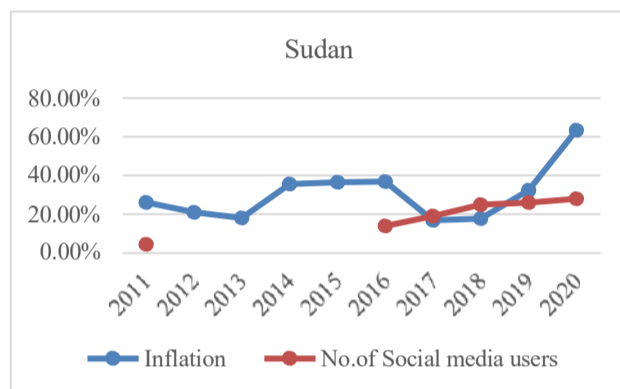

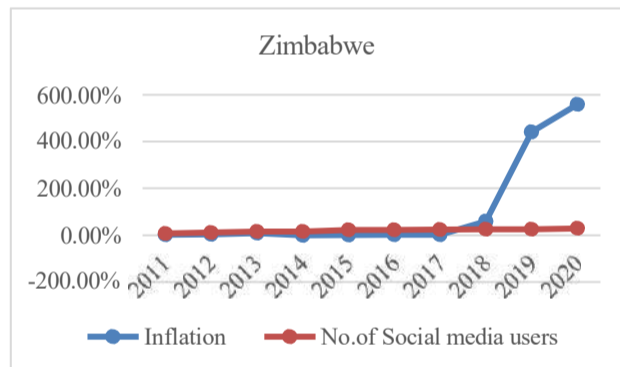Figure 1: Inflation and Social media usage of Sudan

Figure 2: Inflation and Social media usage of Zimbabwe
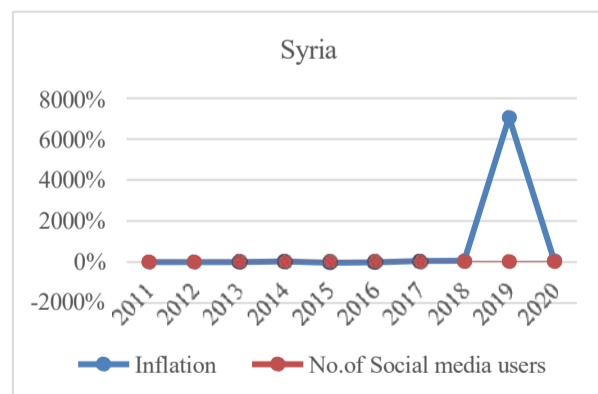

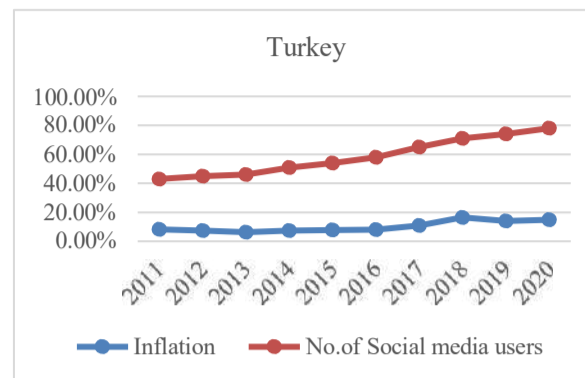Figure 3: Inflation and Social media usage of Syria

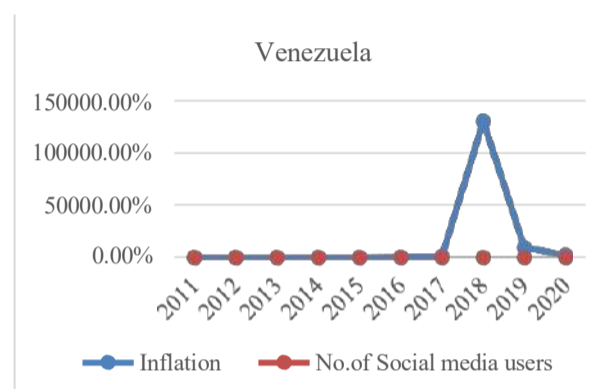Figure 4: Inflation and Social media usage of Turkey

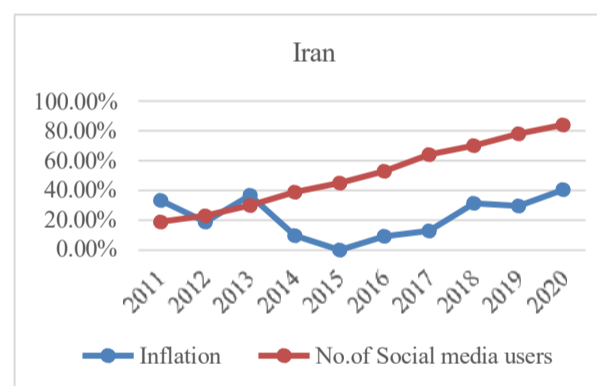Figure 5: Inflation and Social media usage of Venezuela

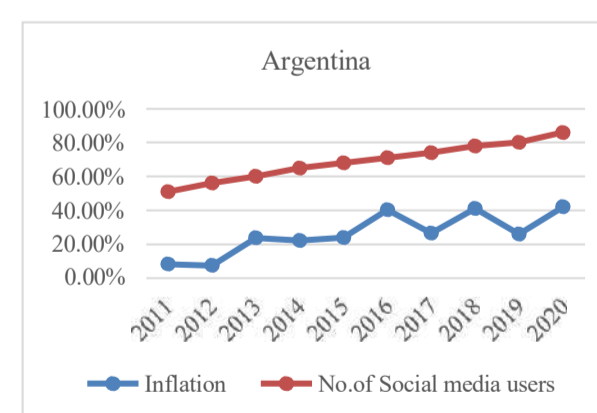Figure 6: Inflation and Social media usage of Iran

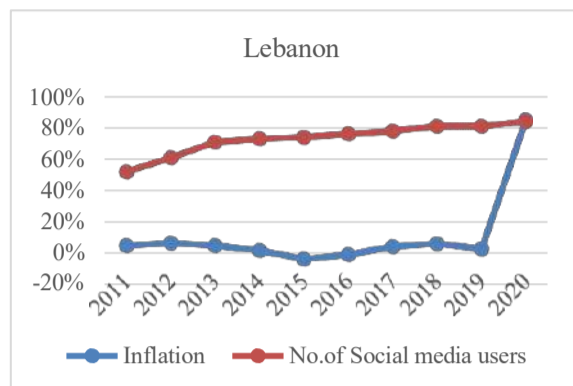Figure 7: Inflation and Social media usage of Argentina

Figure 8: Inflation and Social media usage of Lebanon

4. Results

The social media become an influencer to the economic development as its capability to assist; organizational relationship management, optimization of the operating costs with efficient use of resources, preservation of the values for consumers, provision of quick marketing dynamic updates and improvement of small businesses. However, when consider the statistics, it shows that inflation is increased with the number of social media increase in Argentina, Iran, and Turkey (Figure 4, 6, and 7). However, in Syria, Venezuela, Zimbabwe and Lebanon there is no relationship between inflation and no of social media users as per the charts (Figure 2, 3, 5, and 8). However, when consider the Sudan, it cannot express any

relation due to the lack of data. Therefore, as more than 50% of the countries show no relation, it can state that inflation and number of social media users do not have a proper relationship.

5. Conclusion

Particularly in terms of growth and expansion of the economy, the influence of social media cannot be emphasized. It also contains a lot of hidden values that the long-term growth of the global economy will expose.

Social media impacts to the small business specifically and allowing to properly manage the resources as it assist to capture the market dynamics and preserve the values of the businesses.

Than the whole social media concept, the different platforms such as WhatsApp, YouTube and Twitter, are differently effect on the economy. Then future studies should focus on the specific values and services provided by the individual platform when finding the relations with economic aspects.

However, after a brief systematic survey it found that social media effects on economy both positively & negatively which the same as starting point of this research.

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Public Bus Tracking System for Sri Lanka

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Abstract: *The COVID-19 pandemic has put an entire world on lockdown for the first time. People are afraid to go to crowded places like bus stops during this situation. Further today, public transportation services are in a lot of trouble facing people. such as traffic congestion, unexpected delays, and irregular vehicle dispatching times. Manually, the system has encountered the security problem of the data and lost the records. Due to those issues, automated systems have developed for public bus transport. These systems can solve some problems, but they are not yet finished with all of the issues in public bus transportation. due to a variety of advantages, most people choose to take public transportation rather than drive their own vehicles. If people know the schedule for their route bus through their mobile devices, they can arrive at the bus stop in plenty of time to avoid waiting and reduce time wasted. High technology has a major impact on human life and allows us to significantly simplify and automate daily activities. General computerization allows for easier access to all kinds of information needed in daily life, as well as more specialized ones. The proposed system is to develop web-based and mobile based applications for public people because they waste money and time in daily life. Global Positioning Technology System (GPS) technology use for system development. It can be easily tracking the location. Therefore, people can reduce their difficulties and be enabled to access and manage the system easily.*

Keywords: *Bus Tracking system, Android application, GPS*

1. Introduction

Sri Lanka is still a developing country, both culturally and economically. The government should provide a lot of facilities for Sri Lankans. Buses and railways are used to provide public transportation in Sri Lanka. The Sri Lankan Transport Board and numerous private bus companies operate passenger bus services. Around half of the model's modes of transportation are public transportation. The operation and improvement of public transit are prioritized in transportation master plans and government budgets. Public bus transport is most public people's day-to-day transport. Today, public transportation services are in a lot of trouble facing people. As a result, many public buses people are having difficulty in daily life because buses are not working at the right time, drivers are violating the rules

and regulations, and due to increased traffic, they waste time. Timetables, bus routes, and services are all available under the existing system, but people can make some progress in resolving their transportation issues.

In the existing system, people can access the management system and see the timetable of buses and routes. Furthermore, that the management system has bus fares, the comment section is included. Additionally, that system was developed after developing and managing the mobile application. These existing systems offer a lot of advantages for people attempting to resolve some issues. However, not all issues in public bus transportation have been resolved. Until now, there has been no efficient mechanism for tracking bus delays, bus location at the time, drivers, conductors, and bus details and expected time. There is no way to know if disciplinary procedures have been followed. As a result, people are dissatisfied with public transportation, particularly the bus. Due to those issues, automated systems have developed for public bus transport. While these systems can help with some issues, they are far from solving all of the problems in public transportation. Therefore, the purpose of this public bus tracking management system in Sri Lanka.

There may be some human and environmental consequences because of the software project. However, because this is a software endeavor, human and environmental concerns were minimal. There should be a plan in place to minimize any complications that may arise during the process. To safeguard people and the environment from risks. The system developer should protect the system record from unauthorized access. Implement the system for strong authentication. Sharing the location is most important. As a result, better technology should be used to safeguard geo-information. The proposed system includes web-based applications and mobile application approaches, which save time and money, as expected. It facilitates the management of outpatient data and allows for quick and easy access to information. In that system, you can access three parties. There are admin, drivers, and public passengers. Admin can modify the timetable, bus conductor, driver, and bus details, as well as the bus fare and respond to the disciplinary procedure section. That section includes what rules and regulations

are accepted for the driver and conductor, and how to get the action for violating those rules and regulations. All buses have a unique number and the driver enters that number into their mobile. Then the driver can track the Global Positoning System (GPS) and a passenger can connect to the bus and get bus details. The proposed system has a payment gateway feature. It can be useful for passengers to pay for their tickets. Passengers can share their location through Whatsapp. That feature is useful for students because parents know about the current location in real time. Both applications use the database as firebase. Systems are mainly expected to improve public transport reliability and quality, operational cost, investment, and overall system performance. Furthermore, drivers and passengers with good relationships can expect these web-based applications and mobile applications. The Global Positioning System (GPS), the applications are the basis of the solution, which is to provide Sri Lanka with a smart real-time bus tracking device to upgrade the real - time bus tracking system. The built-in GPS module locates the bus with the greatest accuracy and transmits the information. The Bus Dispatcher can make informed decisions regarding the direction of the bus because of the availability of this data. By using maps that give a clear representation of the buses' location, location data can be further analysed to include visual positioning. The administration can notice potential safety issues utilizing contact and respond swiftly by combining positioning data with bus speed. Sri Lanka is still a technologically advanced developing country. Additionally, automation is becoming more and more common in Sri Lankan institutions. As a result, Sri Lanka Bus System continues to use outdated technology. Additionally, Sri Lanka has a fragile economy. Therefore, expensive systems cannot be included in the design of real-time bus tracking systems for Sri Lanka. It should consist of inexpensive devices like GPS and efficient and simple payment methods. The bus tracking system can overcome existing systems issues. Because this bus tracking system give effective and efficiently payment method, most accurate information about bus tracking system through GPS. Therefore, this bus tracking system very useful persons and it can be low-cost budget. This paper provides a review of the background research, which also includes public transportation tracking systems.

The literature review, methodology, and conclusion are the three main sections that are covered in this essay. A comparison of similar papers that have already been published is included in the first section. The development process involving the selection of components and the system architecture diagram and User interface design are discussed in methodology.

2. Related Work

The ever-increasing need for transportation is one of our society's most pressing issues today. The days of simply

building new roads and other transportation infrastructure to meet demand in the transportation sector are long gone. Through careful planning, administration, and maintenance, transportation development is increasingly geared toward maximizing the utilization of existing infrastructure.

According to CTrack [1] is an energy-efficient, GPS-free system for trajectory mapping based on cellular tower fingerprints. The most important lesson we learned was that sequencing cellular fingerprints before matching them is critical to achieving good accuracy. CTrack implementation consumes almost no extra energy while achieving high mapping accuracy, making it a good way to distribute collaborative trajectory-based applications such as traffic monitoring to many users without worrying about energy consumption or battery drain. A GPS-free approach to trajectory matching also allows for more fine-grained location services to be provided on the world's most popular, cheapest phones that lack GPS but do have GSM connectivity. [2] Location Based Services system offer subscribers personalized services based on their current location. LBS provide tools for effective management and continuous control.[3] The mobile application called AS-OJEK use to development phase GPS, GIS, Mobile, Web applications. RAD was used because this methodology was designed to be more adaptable to changes and to accept new inputs, such as features and functions, at all stages of the development process. [4] A worker cell and advanced cells make up the framework. The framework can demonstrate its performance by following school transportation from any location. That is a less expensive. [5] The system describes the Vehicle Tracking System in detail under the Android operating system. The future of mobile phones is bright, especially smart phones with Android systems. Overall, this application is easy to use and performs well.[6] The paper could be improved by attaching a more sensitive GPS shield to provide the precise location. Furthermore, if an application is developed to receive SMS messages from SIM808 and directly take the coordinates and show the location in Google map, the tracking will be simplified.

According [7] The application has been designed and tested, and the users are confident that it provides real-time service and is very useful to them. [8] Users of the system can keep an eye on the public transportation vehicle in real-time. Users can view the schedule and cost of their trip while selecting their preferred mode of public transportation. The positioning device installed on each vehicle allows for the app to track the location of the vehicle in real time. Future work will involve utilizing and integrating a separate database with the current app. [9] AVL systems are a diverse group of systems that deal with the spatiotemporal information obtained from moving objects of the point type. The main parts of these systems are those responsible for determining the vehicle's geographic location and for using wireless telecommunication to send this information to the control center. Today's systems almost completely rely on satellite-based positioning (GPS) to determine vehicle location and packet data transfer over cellular networks to

send that information to the control center. This design proved to be the most dependable as well as the most cost-effective. Custom sensors for detecting bus stops and an independent wireless telecommunication network are not necessary for city services implementing bus tracking. [10] Goo-Tracking system utilizing open-source software and affordable hardware. The viability of using the Goo-tracking system for fleet management has been demonstrated. When used in conjunction with a car alarm system, it can also be used for lost vehicle tracking.[11] Intelligent Transport System measures that have undergone modelling exercises and the anticipated outcomes based on the modelling exercises.[12] The system made up of a server and mobile devices. The system can show off how well it works by tracking college buses from any location. Our system is also inexpensive because it doesn't need any additional hardware to track a user's location. According to [13] conclude that a method can improve the effectiveness of transportation network design by utilizing the advantages of theoretical research and commercial software.

A lot of systems are developed by only using Android applications. However, other systems have been developed to manufacture using the Internet of Things.[14] The system, which makes use of a wireless RFID module, is designed to give users all the information they need to customize their schedules for public transportation. To improve the system's dependability, some changes can be made for upcoming projects. The addition of a mobile app for users of Android and iOS can enhance this system. Being ready for natural calamities is essential as population density rises. People should be led to safe regions in the event of a natural disaster, such as an earthquake. In the immediate aftermath of the earthquake, it is simpler to locate missing persons and provide for people's needs when survivors are directed to a specified gathering location. To maintain safety, silence while working, and to ease admission and leave from the area, persons should be directed to the assembly places when in the impacted regions.[15] Due to this, it is crucial to carefully research the accessibility of the Emergency Evacuation and Meeting Area (EEMA). The article [16] explains how to use the GPS module and Android SDK on an example public transportation scheduling service. Developed application is an illustration of how an Android-powered smartphone with a GPS receiver built in may be used as a tool for quick schedule searches of public transportation. Two programs that operate on a client-server architecture have been created for this aim. The first is a mobile application, whose function is to gather location-related data, provide coordinates over a REST web service, receive an XML response with the required information, and display data using Google Maps. The second program is a web application created in Java that updates timetable information and searches for connections and the next bus stops.

Many existing systems have been developed to be high-tech, with high budgets and high security. The proposed bus tracking system can develop too easily, so it can get more accurate information. Further systems connect with firebase. Firebase is a high-security database and it can be developed very easily. Therefore, the proposed system is different from other systems.

3. Methodology

The proposed solution is a web-based application that will allow the user to check the status of the bus as well as estimate how long it will take the bus to arrive at the user's current position. The system's Web-based application and mobile applications will be interfacing with the updated database to provide the real-time data to the user, hence enhancing the user experience.

A. Data Collection

Collecting the data is the most important part because previous timetables, drive details, and bus details are needed to implement the system. In data collection, anticipate the gathered data in district. because it can be useful to develop a public bus tracking system.

B. Data Analysis

This system is developed to track the location. Google Map can track the location and it can give the bus shop, public places, and private places. That data can be useful to track the Global Positioning System (GPS). Get the survey details one by one, check and solve the problem in the system in that analysis data. These are all stored in the database. It is very useful for securing data and easily implementing and managing data.

C. Process

Admin can access management system and edit and upload the system details. Further admin should response the Disciplinary procedure section. System have chatbot it can be useful passenger because solve some issues in the transport. Passenger can be accessing the public bus tracking system and see the timetable, route of bus details. But them did not can see the driver and bus details see. Their want to see that driver and bus detail install the mobile application. Then registration to the application. After their already access application. Register the application their can see the detail and track to the bus and expect time of it. Buses have unique number. Driver can access to the mobile application and track the location. Google Map support to the find the location. The Mobile Application have New Features. Passenger can share the location with another person through Whatsapp. Passenger can pay the bus ticket through the Payment Gateway.
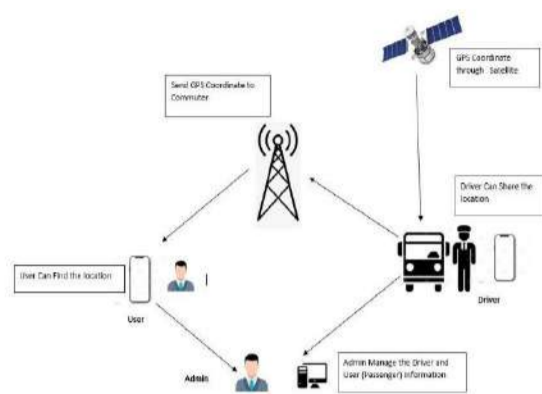
Figure 1. System Architecture
Source: KDU IRC 2022

D. System Development

The proposed system develops web applications and mobile applications. Both the main objectives of both applications are administrative (monitor the timing and routes), tracking the location, analysis (planning and scheduling of services), database management, high security and emergency situations can be informed. These objectives are more important to develop with both applications. The Wednesday application was created with Front End for HTML, CSS, JavaScript, and Backend for PHP, and it was linked to Firebase. Users of Firebase's apps can easily store their photos and videos on the cloud thanks to the Firebase Cloud Storage feature. The Firebase SDK integrates cloud storage technology, enabling quick uploading of files to the cloud. Firebase using the proposed system is most reliable and can be secure to users' data in the event of unauthorized access. Furthermore, Firebase Connect works with both web applications and mobile applications. Therefore, it can easily manage both applications. Mobile Application created this app with Android Studio and the Flutter Framework. Figma Mobile Application User Interface Preferences Connect to GPS using the Google API. Programmatic interfaces to Google Cloud Platform services are provided by Google Cloud APIs. They are an essential component of the Google Cloud Platform, enabling you to quickly and easily add the power of everything from computing to networking to storage to machine learning-based data analysis to applications. The Google API Key can be used to track the location of the driver and passengers. A passenger can share the location with another person.

Google API keys are unique to each other. That key comes with share options. It has benefits for mobile application development. payment gateway used for passengers. They can pay the ticket through the payment option. Passengers pay the ticket automatically. The system provides payment details through the IPG File. LankaQR is used for payment options. It can be visibility and trackability of their money, the ability to scan and pay any LankaQR enabled merchant, all key banking services in one place, and the ability to manage multiple bank accounts and cards in one place. In different interfaces, a mobile application was developed for Passenger (Figure 2) and Driver (Figure 3). It is possible for them to be user-friendly with each other.
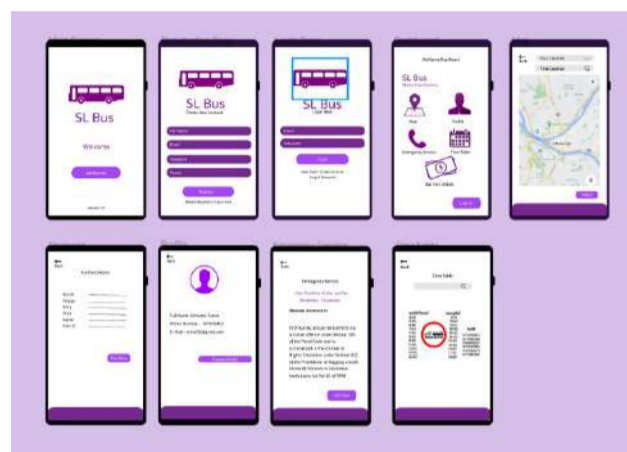

Figure 2. Passenger User Interface
Source: KDU IRC 2022
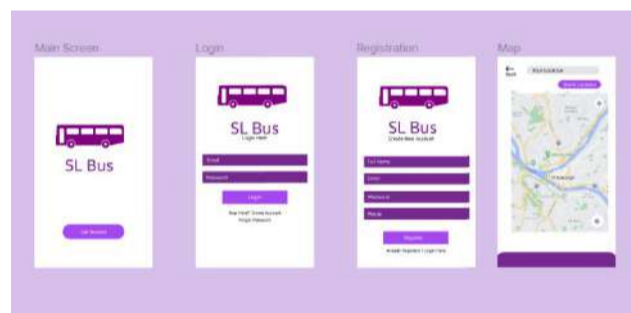
Figure 3. Driver User Interface
Source: KDU IRC 2022

4. Discussion

The proposed System was developed with the passengers' safety and social distance in mind, in order to make it easier to transport people in these vehicles during pandemic situations. Consequently, one of the preferred options for both adults and children is the tracking system. Public Bus Tracking System develop to increase the reliability, data accurate, Track the location for passenger and Bus Drivers for manage their busy life and protectively finish their Transport. Use the GPS technology to track the location. It can easily track the location. Identify their responsibilities and Rules and Regulations. Both Web Application and Mobile Application are better communication and Relationship between driver and Passenger, Reduce the Time and Money waiting, Investment and improve the

facility of System, Operational Cost of System, Less the system problem and manage easily, User Friendly Environment and Reliability and Accurate Information include the proposed System. Several systems on the buses can be incorporated into one of these systems. This Real-Time Bus Tracking System can be very successful. But, before referring to such a system, it should provide an understanding of how to use this system. This is due to the fact that a lot of elderly people did not understand technology and reported that they did not understand the system. Sri Lanka Bus will be able to achieve a number of facilities by operating as such a system and application. Furthermore, the proposed system requires future work to develop the seat booking system.

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Designing a Bag for Computing Students of General Sir John Kotelawala Defence University by Using a Kansei Engineering Methodology

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Abstract: As computing undergraduate students, a bag that can accommodate all personal requirements is essential during university life. The bag itself should possess qualities such as space, durability, comfortability, safety, and most importantly provide proper protection for electronic devices carried by computing students. This study aims to design a bag that addresses the existing problems in the bag provided by the university for computing undergraduates. This paper presents an integrative framework of Kansei Engineering (KE), and the Kano model (KM) applied to produce the design of the bag. To explore the relationship between the quality attributes of the design and Kansei, the Kano model is incorporated into KE, which collects and communicates the emotional demands of the consumer. In this study, the bag used daily by computing students is utilized as a case study to demonstrate how KE and KM are integrated into the product development process. The results of this research were generated from thirteen Kansei words which were produced from a questionnaire. The final design of the bag was developed by evaluating total customer satisfaction. As per the results, the final design of the bag was of urban shape with a padded top grip and straps. Polyurethane/ Thermoplastic Polyurethane (PU/TPU) was chosen as the outer fabric for durability and water-resistant quality while polyester ripstop was chosen as the inner lining for the bag to make it lightweight.

Keywords: Kansei Engineering, Kano Model, University Bag, Computing Students

1. Introduction

A commercially successful product is fabricated based on the potential to recognize the latest needs of the consumer and develop a product that is cost-effective to immediately satisfy those needs. When producing a mercantile product, the following aspects must be considered: quality of the product, the time required for development, level of expertise required for development, cost of the product, and cost of development (Ulrich and Eppinger, 2011). A quality product design will benefit the manufacturers in creating profitable products that will appeal to a wide audience (Rodgers and Milton 2011).

"Kansei" in simple terms is a Japanese word that refers to the emotions or psychological feelings of a human (Nagamachi, 2002). It is the psychological feeling or the emotions of the customers from a certain product or an environment. Kansei Engineering refers to the conversion of these emotions or the psychological feeling of a consumer into the design process of a product (Nagamachi, 1999). A product can be a service or information and can be either tangible or intangible. Hence Kansei Engineering can be applied to both tangible and intangible products (Schütte, 2002). When a user or customer decides to acquire a product, a certain image would come up to their mind. For example, when buying a bag, a customer would think of a colour, size, material, design, and many more. Kansei Engineering aims to address these thoughts when designing a new product.

There are three focal points of Kansei Engineering. They are, how to understand the emotions of customers, how to translate the emotions of customers, and how to build a system and organization by adopting Kansei-based Design. Kansei Engineering has been adopted by many automobile companies, the construction industry, home electric appliances, cosmetic industries, and costume industries (Nagamachi, 2002). As Kansei Engineering is a user-centred development approach, the design of a product can be made according to a particular user as it focuses on their desires and demands. When identifying the user's thoughts, it is necessary to find appropriate Kansei words that represent the customer's thoughts accurately.

Most computing students find the KDU bag to be exhausting to carry because of its weight. The material of the bag is of lower quality and is not very durable as it is not fabricated with a strong handle, straps, and zippers. The KDU backpack does not have enough space to carry all the necessities for a computing student, particularly because there is insufficient room for a laptop or any in it. The laptop compartment lacks adequate padding, which makes it extremely unsafe as the laptop can be damaged if the bag drops. Moreover, the laptop may potentially be harmed if water leaks into the backpack as the bag or the laptop compartment is not water-resistant. This can certainly make carrying the laptop in the KDU bag challenging on rainy days.

The back of the bag is also not completely padded, which might result in unnecessary additional pressure causing discomfort that will eventually lead to pain in the shoulders, neck, and back when worn regularly. The appearance of the bag is not significantly attractive as the shape of the bag is not appealing to most KDU computing students and as all the KDU bags are identical, it is particularly challenging to uniquely identify each one separately especially when a lot of bags are placed together.

As the current KDU bag provided for computing students have certain issues, an appealing new bag is in need. This research aims to utilize the Kansei Engineering Method to produce an appealing design for a bag for KDU computing students that is comfortable, spacious, high quality, strong, long-lasting, lightweight, water-resistant, and most importantly provides proper protection for electronic devices carried by computing students.

This paper discusses the steps involved in the designing of a proper bag for computing students of KDU with the use of Kansei engineering. It consists of previous similar work, methodology and experimental design, results and discussion, and conclusion.

2. Literature Review

A. Sling Bag

In the paper, Chalis Fajri Hasibuan explains the design of a sling bag by using Kansei Engineering technology (Fajri Hasibuan, 2020). The research aim was to develop a women's bag by using the sling bag as a model which showed a decline in sales. Data was gathered using direct observations and interviews which were then analyzed in designing the sling bag. The material of the sling bag was designed using fabric, the shape of the bag was a rectangle, the size is medium-sized, and the colour was a variant that is black and milk brown. In this research, 23 Kansei words were initially selected, which was later reduced to 7. The 7 Kansei words include cool, elegant, simple, long-lasting, light, medium, and plain.

B. Baby Bag

The baby bag was designed using Kansei Engineering by D Janari and A Rakhmawati to satisfy the customer expectations in the market. It was designed by focusing on 18 Kansei words and three design parts. The research was conducted using interviews and a series of questionnaires which were performed in 3 stages. The Kansei words are selected such that each word was selected by more than 90 percent of the total respondents. Kansei words of special, regular, small, and complicated were excluded as they were selected by less than 90% of the total respondents. The research was carried out by identifying the main features of the baby bag such as a pocket for the bottle, space needed

for clothes, a pocket for heating the bottle, diaper space and top, and side and shoulder grips (Janari and Rakhmawati, 2016).

III. METHODOLOGY AND EXPERIMENTAL DESIGN
A. Materials and methods
One of the mainly used methods for product development is 'Kansei Analysis' which we have employed in designing our product. To commence the Kansei analysis, the concept related to our study is designing a bag for computing students of KDU which can serve most of the requirements of a computing undergraduate. As undergraduates of KDU, our group was well aware of the problems we face daily when using the existing bag design and proposed a new design to address the above-mentioned issues.

The preliminary stage consisted of identifying the function of each part of the bag that could be separated as compartments which are mentioned below.

- Space for books, water bottle, and lunch box
- Space for laptop and other related accessories (laptop charger, mouse, pen drives, cables, etc.)
- An easily accessible hidden pocket that can hold cash, wallet, and University ID

In addition to the compartments, the proposed design will contain a top handle that can carry the bag vertically. We addressed the lack of uniqueness in the existing design by providing a small transparent holder in the top handle that can place the consumer's name tag to easily identify one's bag. It also contains typical shoulder straps to be carried as a backpack. The initially proposed design with dimensions of 12.7x5x17 inches (Length x Width x Height) in comparison with the existing design is shown below.

Table 1: Design of the bag

Existing bag design	Initially proposed design
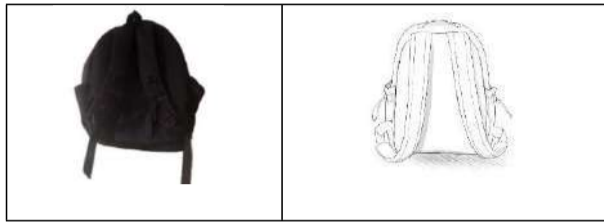
Source: Authors

In the next stage of the statistical procedure, a set of suitable Kansei words related to the product were selected. The participants of the survey will rate the design sample using the Kansei words through a Semantic Differential (SD) scale followed by a statistical analysis of the relationship between Kansei words and the product design elements which will be discussed in detail in the following sections.

B. Data collection techniques

The research was conducted by means of a questionnaire, interviews, and also through the data gathered by direct observations(Schütte, 2002). The target audience of the survey is computing undergraduates of KDU. The questionnaire included feedback on the existing bag design and an initially proposed design sample based on the chosen set of Kansei words. Thereby collected feedback helped us to create a product that is multi-functional in design which will be discussed in the following sections.

C. Collection of Kansei Words

Kansei words can generally vary from 50-600 based on the chosen domain. Thus, it was necessary to collect Kansei words that will reflect the needs of the user and help us in the design process(Hattori et al., 2011). Initially, a larger database of words was chosen which were then reduced to obtain a smaller set of words that complemented the design elements of the proposed bag design (Backar, 2019).
Table 2 shows the set of 13 words that were collected that matched the design of the bag.

Figure **1**. Identified Kansei words

Source: Authors

D. Semantic Differential (SD) scale

Determining the final design depends on the results of the data processing on Kansei engineering. For this purpose, a rating scale called a 'Semantic differential scale' is used which assesses the connotative significance of things, actions, and ideas. The connotations are a standard visual analog scale (vas) and a 7-grade Likert scale that is used to determine how someone feels about a certain object, event, or concept. The SD scale we employed in our questionnaire was of 5 levels ranging from 1-5. The extremes on the opposing sides of the scales were represented as 1 – "not at all" and 5- "very much" to make sure the word was clearly understood by the participants.
Table 2 shows an example of the SD response of participant no 1.

Table 2: An example of the response of participant 1

	Kansei word	1	2	3	4	5
1	Comfortable				×	
2	Light		×			
3	Water-Resistant					×
4	Spacious					×
5	Safe				×	
6	Durable					×

Source: Authors

E. Importance weighting

In our study, we used the SD scale to pick the most important words out of the already chosen set of 13 words. The words with a high grade and a higher calculated weight are chosen as important words (Backar, 2019).

$$h \quad i\, h \quad = \frac{(\quad al \quad a \quad h \quad)}{(t \quad l \quad i \quad h \quad h \quad D \quad al}$$

$$* N . \quad a \quad i\, i\, a \quad)$$

Therefore, according to the chosen SD scale and no. of participants in our study, the formula to calculate weight is as follows.

$$h \quad i\, h \quad = \frac{(h \quad al \quad a \quad)(5 * \, \overset{h}{8}8)}{}$$

The following table represents the grades and weights of the Kansei words.

Table 3: Grade and weighting of Kansei words

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Kansei word	Grade	Weight
Unique	132	0.3000000000
Simple	65	0.1477272727
Strong	136	0.3090909090
Elegant	105	0.2386363636
Quality	136	0.3090909090
Light	177	0.4022727272
Comfortable	190	0.4318181818
Safe	190	0.4318181818
Minimalist	123	0.2795454545
Durable	167	0.3795454545
Water-resistant	155	0.3522727272
Spacious	173	0.3931818181
Size	103	0.2340909090

Source: Authors

The words that have the highest degrees and the highest were selected and those words are comfortable, safe, spacious, light, durable, and water-resistant.

F. Relating KE engineering characteristics
By brainstorming, a certain set of elements or characteristics of the product design was chosen, all of which are related to the six most important Kansei words identified. Those important Kansei words and selected product characteristics were then combined to create a questionnaire which is known as the 'Kano Questionnaire'. We used a Kano Questionnaire to classify customer requirements through a separate questionnaire (Rajasekera and Karunasena, 2013). In Kano Questionnaire, the appropriate questions involving the requirements of the product were included.

The Kano Questionnaire for this study is divided into two sections, functional questions, and dysfunctional questions to assess the bag's design. (Shape, handle's grip, and the material properties - durable, light, and water-resistant)

The functional form of the question is written as to how a customer would feel if that feature were present in the product and the dysfunctional form of the question is

Written as to how acustomer would feel if that feature is not present in the product. Simply, the dysfunctional form of the question is the negative of the functional question (Usertimes, 2019).

In our study, we created twenty-four questions in total, twelve of which are functional and twelve of which are dysfunctional. The functional questions from the Kano Questionnaire that we prepared are displayed in Tabl

Table 4: An example of functional questions in the Kano questionnaire

The shape of the bag
1). The 'urban' shape makes the bag spacious. 1- Like. 2- Must be. 3- neutral. 4- Live with. 5- Dislike. 2). The 'school' shape makes the bag spacious. 1- Like. 2- Must be. 3- neutral. 4- Live with. 5- Dislike.
Top handle
3). A padded top handle seems to be more comfortable. 1- Like. 2- Must be. 3- neutral. 4- Live with. 5- Dislike. 4). A non-padded top handle seems to be more comfortable. 1- Like. 2- Must be. 3- neutral. 4- Live with. 5- Dislike.
Material of the bag
• Durable:
5). A bag made of Ripstop Nylon seems to be durable. 1- Like. 2- Must be. 3- neutral. 4- Live with. 5- Dislike. 6). A bag made of PU/TPU seems to be durable. 1- Like. 2- Must be. 3- neutral. 4- Live with. 5- Dislike. 7). A bag made of Nylon seems to be durable. 1- Like. 2- Must be. 3- neutral. 4- Live with. 5- Dislike.
• Light:
). A bag made of PU/TPU (polyurethane/thermoplastic polyurethane) makes it light. 1- Like. 2- Must be. 3- neutral. 4- Live with. 5- Dislike. 9). A bag made of Polyester Ripstop makes it light. 1- Like. 2- Must be. 3- neutral. 4- Live with. 5- Dislike. 10). A bag made of Inverted Polyester makes it light.

1- Like. 2- Must be. 3- neutral. 4- Live with. 5- Dislike.
•   Water-resistant:
11). A bag made of PU/TPU makes it water-resistant.
1- Like. 2- Must be. 3- neutral. 4- Live with. 5- Dislike.
12). A bag made of Nylon makes it water-resistant.
1- Like. 2- Must be. 3- neutral. 4- Live with. 5- Dislike.

Source: Authors

The questionnaires are distributed to 40 participants. The Kano evaluation table (Figure 1) can be used to classify product features into the following categories: A (attractive), O (one-dimensional), M (must be), Q (questionable), I (indifferent), and R. (reverse). The data is then subjected to mathematical analysis. The goal of the mathematical model is to determine if customers are satisfied or dissatisfied (Backar, 2019):

Customer satisfaction (S.C) = (A+O) / (A+O+M+I)

Customer dissatisfaction (D.C) = (O+M) / (A+O+M+I)

Total C.S.C (T.C.S) = (A-M) / (A+O+M+I)

Figure 22. Kano Evaluation Table/ Kano Matrix

Source: Pan Qiting, Uno and Kubota, 2013

Customer Requirements:

A: Attractive, O: One dimensional, M: Must be, Q: Questionable result, R: Reverse, I: Indifferent

Later, the Kano Questionnaire's gathered results were analysed, and the consumer requirements were identified by those results.

3. Results and Discussion

In the data collection survey, some basic questions were asked regarding the current KDU bag from KDU computing undergraduates which helped to identify the requirements that they look for in a bag for daily use.

A. Data Gathered from the Survey on the Current KDU Bag

Based on the survey conducted, 73.3% of undergraduates are not satisfied with the appearance of the current bag of KDU. The survey results represent that 67% of undergraduates are satisfied with the space of the bag and 80.7% of undergraduates are not satisfied with how the bag

protects personal devices such as laptop and other accessories. The survey results showed that 78.4% of the survey participants who are undergraduates are not happy with the durability of the bag. It further implies that 84.1% of undergraduates are finding it to difficult uniquely identify their bags.

Other suggestions regarding a new bag design are mentioned below.

- The colour must be black.
- A bag with a comfortable design.
- An elegant bag that is lightweight and minimal.
- Hidden pocket for money or any other valuables.
- A bag that doesn't change its shape when we packed our goods.
- Change the fabric.

B. Survey Results of Kansei Words

The overall survey results of the participants on the selected Kansei words regarding the initial design are shown below.

Unique (58%)	Light (39.8%)
Simple (46.6%)	Durable (63.6%)
Strong (65.9%)	Water Resistant (62.5%)
Size (42%)	Comfortable (72.7%)
Elegant (31.8%)	Spacious (38.6%)
Quality (67%)	Minimal (23.9%)

Other responses except for the Kansei words.

- Strong Zippers and Strong Plastic Parts
- The shape of the bag is very important

C. Feedback for the Proposed Design

After a survey on behalf of the proposed design, the results were obtained relatively based on opinions on a scale of 1-5. According to the results, 31.8% expected the comfortability of the bag to be 3 on a scale of 1-5. When considering the weight of the bag, an equal score is displayed on 3 and 5 on a scale of 1-5.
As for the water-resistance quality, 26.1% of the population has given a score of 5 on a scale of 1-5. Regarding bag space, 31.8% of the population voted on a score of 4 on a scale of 1-5. When it comes to durability 28.4% of the population have voted on a score of 5 which is the highest on a scale from 1-5. Based on the survey 28.4% of the population have voted on a score of 5 on a scale from 1-5 where they expect higher safety from the bag to their accessories.

D. Discussion

After thoroughly analysing the results collected through the participants of the surveys, we finalized the design of the bag. As Kansei is based on human feelings and a design that affects human emotions, the goal was to come up with a design that will be appealing to the audience as well as serve the functionalities optimally.

Through careful consideration, the ideal material was chosen for the building of the bag. As for the chosen fabrics; outer fabric - PU /TPU, straps – webbing, and inner lining – polyester ripstop. Also, by using PU/TPU as the outer fabric the bag will have a finish resistant to water and wear while retaining its shape. Polyester ripstop was chosen as it will make the bag lightweight. Backstrap straps tend to get the most wear out of any part of the bag. Therefore, we decided on webbing for the straps (commonly made from cotton, nylon, polyester, or polypropylene) or ripstop nylon, both of which are durable enough to stand up to the pressures of frequent handling.

In addition to that, the top handle and straps are padded to provide a comfortable grip when carrying. The back of the bag is padded as well reducing the pressure applied to the bag's content while providing protection. The bag will have a name tag holder as per the initial sketch (Figure 5). The black colour was chosen as the bag's colour as most of the participants preferred black.

The inside of the bag contains a separate padded compartment for the laptop that can hold the laptop in a fixed position through a small strap (Figure 4). Other accessories can be placed in the pockets placed outside the laptop compartment. We also included the suggestion for a hidden pocket to hold things of value (Figure 4).

The dimensions of the bag were decided as 12.7x5x17 inches (Length x Width x Height) where any laptop size can be contained unlike the current KDU bag where 17-inch laptops cannot fit inside (Figure 4). The adjustable side pockets can be used to carry anything including a water bottle of any size. Moreover, the design was made to stand out as simple, elegant, and minimal while highlighting the university logo (Figure 4).

Figure 3. Front view of the final design

Source: Authors

Figure 4. Back view of the final design

Source: Authors

Figure 5. Cross-sectional view of the final design
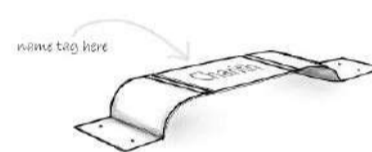
Source: Authors

Figure 6. Name tag holder on the top handle

Source: Authors

4. Conclusion

The purpose of this study was to design a bag for KDU computing students by integrating the Kansei Engineering approach and the Kano.

Following an analysis of the issues faced with the bag's current design, a set of appropriate Kansei words were chosen according to the Kansei methodology approach to suggest a new design that would address the existing problems. An initial survey was conducted to gather information about opinions regarding the current bag design and the initially suggested design based on the selected set of Kansei words. Then, from the selected 13 words, the most important words were selected based on their grades and weights. The six most significant Kansei words were then combined with a set of product design elements or characteristics to construct a Kano questionnaire. Different aspects of the design of the bag (shape, handle grip, and material properties—durable, light, and water-resistant) were evaluated in this questionnaire. The specific consumer requirements were classified using the data obtained from the Kano questionnaire, and then the customers' satisfaction and dissatisfaction factors were determined.

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Considering the benefits of this new design, such as the ease of storing any size laptop and the safety of carrying cash, credit cards, keys, etc. in hidden compartments can be highlighted. Additionally, the design is comfortable and convenient to use and is elegant and minimal. Moreover, the bag also includes several pouches and zippered pockets for organizing items. Through the use of padded handles, straps, and padded back, this bag addresses health issues such as excessive strain on bones and muscles, muscular strains, and spasms of the back and neck.

By analyzing the data obtained, the bag was decided to be built using PU/TPU fabric as it is a water-resistant, wear-resistant material that can retain its shape. However, as the PU/TPU material is significantly more expensive in comparison to other materials, this might be a shortcoming in the current design as the selected materials can be costly. This can be improved in the future through additional research, which would help to identify reasonably priced materials that can maintain the quality and properties of the bag.

Nevertheless, the design can be incorporated with built-in headphone ports, charging ports to charge laptops and mobile phones simultaneously as well as appropriate pockets and pouches in the future.

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Acknowledgment

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Web-Based Student Counselling Management System for Kotelawala Defence University

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Abstract: *Today's education system is only focusing on students' abilities in the academic area, not giving much attention to their emotional aspects. Psychological problems include fear of failing, family pressure, competitive pressure, depression, academic stress, homesickness, and relationship issues are the major issues that students face and find hard to deal with. Student Counselling is a very important aspect for the students because it helps to save them from all issues that can negatively impact their studies. The students are under extreme pressure that needs to be heard, but they may not be able to verbalize their problems in front of the counsellors as they do not feel comfortable speaking, and, they do not like to expose others when they meet a counsellor. Therefore, the necessity for an online system that can manage all counselling processes was identified. Even though many counselling management systems have been introduced to the market, those systems are not capable of using in particular universities, institutes, etc. Our proposed system has the capability of implementing in institutes and doing online counselling via chat, video conferencing, or meeting in person as preferred by the user.*

Keywords: *Psychological problems, Student counselling, Counselling management systems*

1. Introduction

The internet is the world's largest information and communication network, and its value is growing all the time. Today, much like the telephone was a few years ago, internet connectivity is largely taken for granted. The internet has become an important component of many teenagers' and adolescents' lives, as well as a common form of contact. Because of the internet's prevalence, individuals working to meet the psychosocial needs of young people must understand its possibilities. This new field of work also opens up new opportunities for engaging people, distributing information, and providing counselling, and thus serves as a complement to traditional counselling services.(Pulat and Yıldırım, 2021)

Today's education system is only focusing on students' abilities in the academic area, not giving much attention to their emotional aspects. Psychological problems include fear of failing, family pressure, competitive pressure, depression, academic stress, homesickness, and relationship issues are the major issues that students face and find hard to deal with. Student Counselling is a very important aspect for the students because it helps to save them from all issues that can negatively impact their studies.

Counselling psychology is a part of psychology that studies and applies research to a variety of topics, including counselling process and outcome, supervision and training, career development and counselling, and preventive and health.(Mielgo-Conde, Seijas-Santos and Grande-De-Prado, 2021) A focus on assets and strengths, person-environment connections, educational and vocational development, brief encounters, and a focus on intact personalities are some of the common themes among counselling psychologists. Online counselling can be a great way to meet someone for the first time and help you overcome your concerns. It can be used as a bridge to face-to-face counselling as well as a stand-alone kind of counselling support.(Sussman, 2004)

Online counselling is a type of professional mental health counselling that takes place over the internet. Instead of traditional face-to-face contacts, skilled professional therapists and individuals seeking counselling services communicate through computer-assisted technologies. Teletherapy, e-therapy, and web counselling are all terms used to describe online counselling. Email, real-time chat, and video conferencing are commonly used to provide services.(Yan, 2012) Online counselling is used by some clients in addition to traditional psychotherapy or nutritional counselling. An increasing number of clients are choosing internet counselling instead of in-person treatment.

There are various advantages to using online counselling. These are some of them:

- Treatments that are accessible: Online access to Mental Health Therapy may assist to reduce the stigma associated with mental illness and make people feel more comfortable talking about their problems.
- Increased comfort and convenience: For both clients and counselors, online counseling can provide greater comfort and convenience. It is possible that counselors or clients will not need to travel to their appointments, making them less

expensive and more comfortable for all parties involved.

- Less expensive: While most counselors charge the same fees for ongoing discussions as they do for direct counseling, online counseling can be less expensive because it does not require travel provided both parties have an internet connection.

Due to the COVID-19 epidemic, the usage of online counselling increased considerably in 2020. As a result of the epidemic, many countries imposed a quarantine to prevent the virus from spreading further. As a result, mental health specialists were unable to meet with their clients in person and had to resort to virtual counselling. In addition to this change, the epidemic and subsequent quarantine made many people frightened and unhappy, increasing the demand for mental health services.(Gading, 2020) Because virtual counselling became so popular during this time, its total use has increased, despite a reduction in the need for social distancing.

Thus, this paper is proposing an intelligent website that provides online counselling for students. Developing a web application that helps to manage the academic and psychological problems of the students without hindering their privacy and handle users as an individual for a better user experience. To achieve the above aim the following key objectives have been identified.

- To study the relationship between academic performance and counseling in a particular institute.
- To facilitate students to achieve their academic and personal goals in a particular institute.
- Support and empower students to develop their potential and improve mental health and wellness.
- To prevent spending money on expensive counseling services and excess travel expenses.
- To identify scenarios and determine issues faced by students.
- To minimize the cost for the physical of the university.
- To help for minimizing the suicide or depression cases among the younger generation in a particular institute.
- To protect the confidentiality of the students.

Most of the students in the KDU have psychological problems including fear of failing, family pressure, competitive pressure, depression, academic stress, homesickness, and relationship issues which can negatively impact their studies. The students have the capability of managing their academic issues with the assistance of the lecturers, but they are not able to manage other psychological problems with a proper counselling system. Another major problem is the high cost of online counselling systems for students and the lack of access to them due to their busy schedules.

2. Literature Review
A. Prevalent Methods

As mentioned earlier, this research is mainly conducted to give a solution to KDU Students to the problem of lack of methods to find a counsellor for their psychological problems. They are unable to find a counsellor in a busy academic life and find their contact details because of this issue. While searching about existing methods students use to find a counsellor, mainly identified methods are as followed,

    a. By searching the internet
    b. From friends who have joined previous counseling.

After identifying the psychological issues of students, the need for a proper database with the details of a counselor was identified. As mentioned above, considering the methods used by the students, the existing methods, and the methods they follow are not very suitable, this literature review identified the techniques previously used by other researchers to implement similar systems and their advantages and drawbacks of them.

B. Development of a usable online counselling management system

This project has identified the themes of personal life counselling management in the state public and private sectors in Malaysia. In this project, ENAI has been developed to strengthen the existing system and has gone
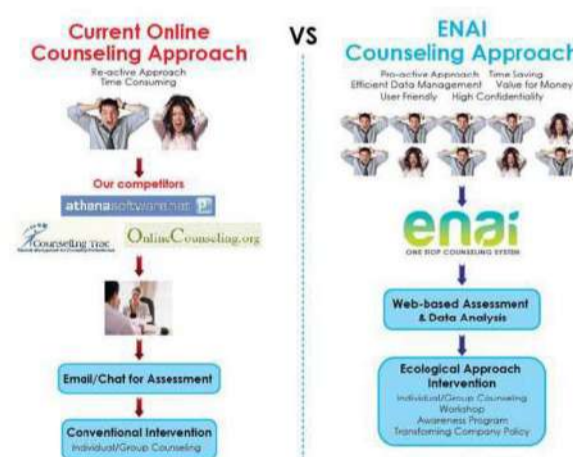

Figure 1: ENAI vs other online counselling systems

Source: Development of a usable online counselling management system Research Paper

through formative and summative evaluations. The results of the ENAI evaluation showed that the system would be able to provide convenience to the three tiers (employer, employees, and counsellor) in the counselling management

of personal life in public and private organizations in Malaysia.

The project involved the development of ENAI through the usage of the System Development Life Cycle (SDLC) and the draft of the theoretical analysis has been divided into three major phases of SDLC. Phase one is the process of gathering information regarding the problems and issues encountered in the current counselling system in the organization. Some of the issues found are difficulties in information sharing among employer and their employees; reluctance due to mistrust and anxiousness in giving private and confidential information to a counsellor or employer; counsellor is not proactive; loss of data and monitoring difficulties.(Hashim *et al.*, 2013)

AI has its unique characteristics which give uniqueness to the system. The figure illustrates the differences between ENAI and other online counselling systems. ENAI provides facilities for the user, especially employees, to share their life problems where they can key in all data problems that they experienced. The data will be sent to the counsellor and administrator. This data will be treated as private and confidential by the counsellor and not to be tried out. This system can only be accessed by the counsellor and the coordinator which means that other employees or employers do not have access to relevant information from colleagues. The problem of missing information or data loss can be avoided as ENAI is integrated with a large database to store all information.

The system also will indicate to the counsellor and administrator the employee's decision whether he/she wants to seek further intervention and treatment. The system also can automatically analyses all data by changing the form of the percentage of employees who are suffering counselling workshopping from liver problems and need further intervention and treatment. There are many methods of intervention that can be done such as an individual c, group counselling workshops, awareness programs, and policies to transform the company.

C. Online Counselling System

The Online Counselling System is developed to enhance counselling. The software will be a great relief to the students. The Online Counselling System is developed to enhance counselling, which fully works online. This software will be a great relief to the student for Reporting, Registration, and searching the information about college and university. This software gives an overview of the entire institute in a short interval of time and will also be a great help to the university to manage the whole counselling procedure by their paperwork and reducing their time.(Jain *et al.*, 2012)

Present system or Existing system of Counselling Management System working manually or computerized in a building. Therefore, all types of works are maintained in the building. So, maintaining all the counselling procedures is very difficult. If we are reporting, then we need to go to the University and get a form for reporting and fill the form and submit the queue conditions. Then verify their form by the university and maintain the record on the computer or register. The system is mainly related to the online counselling management system. Which is developing an online web-based application system, it is necessary to make a thorough study of the existing system. There is no online Counselling Management System. All the information is not maintained globally. Therefore, maintaining all the information about the university is very difficult.

D. KDU Helpline Service (e Counselling)

Considering the KDU Help Desk, a web-based 24/7 mobile counselling service is provided through E KDU. What happens here is that a PDF file containing a doctor and his or her phone number is scheduled for each day of the month and stored in the form for the month. And a student has the ability to physically go and meet this counsellor.(*KDU Helpline - KDU*, no date)

Figure 2: KDU Helpline Service (e-Counselling)

Source: KDU Web-site

E. Development of an online counselling system and usability evaluation

The rising prevalence of mental health diseases is a serious problem for society. Some areas in Asia have no medical facilities and proper mental health care is unavailable. To cope with these problems, the application of ICT for mental health services has been recognized as one of the effective approaches. Therefore, we have been studying and putting

into practice online counselling for people assigned overseas. We constructed a system using agile software development for those assigned overseas in Asia. The first step involved developing a prototype system based on system requirements after we repeatedly discussed system development with people in charge of a clinic. Next, we conducted interviews about the online counselling system. We also discussed and analysed the interviews. Finally, we completed the online Web counselling system by
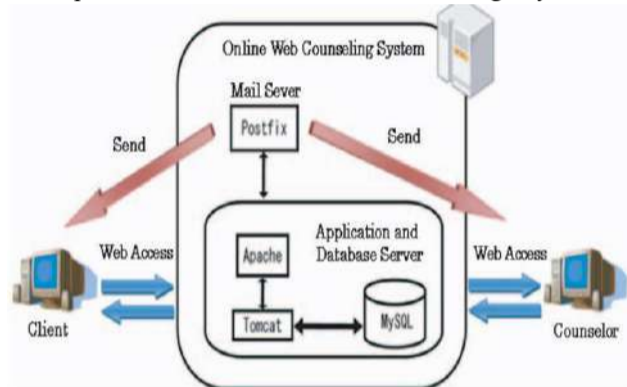

Figure 3: System Configuration

Source: Development of an online counselling system and usability evaluation Research Paper

repeatedly discussing possible improvements with the clinic and then incorporating the changes into the system. Moreover, we evaluated the system by surveying the form of a questionnaire. Since we developed an effective online counselling system using statistical methods, this paper reports on the construction and usability evaluation of the system.

Here developed and operated an online Web counselling system by use of agile software development methodologies to prevent mental health problems from worsening by early negligence for those assigned overseas in Asia. The system is constructed in cooperation with a clinic. The system can offer mental healthcare services by Japanese professionals working in Japan to a lot of Japanese nationals that work in foreign countries. The central focus is on China and Taiwan. All messages are stored in the database of the system to prevent the information from leaking outside. Counsellors can provide consultation via the Web without going to the client's location and the system does not limit the time.(Kato *et al.*, 2011)

The results of the system evaluation showed that demand for original functions outside the system design is high under a system that has a clear intended purpose. It is also important to make someone feel less inhibited by increasing security and improving the system image. Information secrecy and security carry great weight in online counselling systems that are closely associated with mental issues. In the future, we plan to improve the user interface from a psychological standpoint and increase

confidentiality and security. We aim to establish counselling services over the Internet, with a focus on psychological testing.

F. Student counselling management system – A web portal for student counselling

The first phase of a person's life is confined mainly by education and training. While progressing from vocational education and training or to higher education one has the opportunity to build a career. During this transitional stage, one may get diverted from their goals and give information that misleads the parents. Hence, counselling is an important aspect for the students of the current technological generation as an individual counsellor may remain in contact with all individual students as well as parents. Counselling is a process to have two-way communication with students and find out their attributes.

Here, students are allowed to speak whatever they think about their academic environment, the curriculum, and their learning progress. So, collecting all necessary information about the student and making their parents aware of their life becomes essential nowadays. Student Counselling Management System (SCMS) is developed to enhance the counselling process. The current system maintains its records in MS Excel & Microsoft Word documents; however, it is not possible to maintain the data from multiple systems in multi-user environments.

There is a possibility of a lot of duplication and chances of mistakes. Whenever some records are changed, counsellors need to update every document. Also, there is no option to find and print previously saved records. Manual record maintenance also faces various problems like no security; anybody can access any report and with sensitive data, also no summary is available for saved records. SCMS will simplify the process and reduce the manual paperwork. It is used to smoothen the work of each counsellor who is facing problems currently and make complete atomization of manual processes to a computerized system.
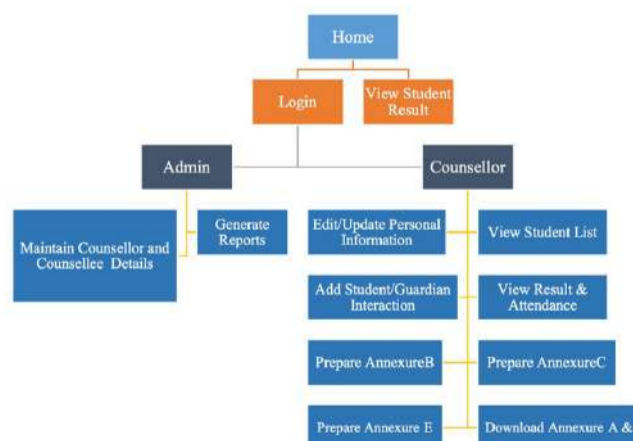
Figure 4: Flow Layout of Student Counselling Management System (SCMS)

Source: Student counselling management system – A web portal for student counselling

SCMS provides a way to store and evaluate the student counselling process in an automated computerized system. It will provide notifications to a counsellor about irregularity or disturbed students whether it is because of mental/emotional or academic stress. Using this system, the counsellor can take necessary action and also notify the guardian or parents about their child. SCMS also provides weekly or monthly reports providing the growth of the students in an academic or social environment.(Patel, 2018)

3. Methodology and Design

A. Requirements gathering and analysis

This study is initiated to find out how to choose a suitable counsellor to help students solve their psychological problems. For that, a survey was conducted using 80 students. The survey was kept as simple as possible to ensure that each participant was comfortable responding. With the results obtained from this survey, the research objectives were defined and then the design of the proposed system was started to meet each of them. The main psychological problems faced by the students are as follows.

- a) Fear of failing
- b) Family pressure
- c) Competitive Pressure
- d) Depression
- e) Academic Stress
- f) Homesick
- g) Relationship Issues

The study problem was identified, and it was then separated into different sub-questions to determine what the exact project goals should be. The following research questions were formulated with the aim of identifying areas that need to be studied in more depth to find a proper solution to the research problem. They clearly define the research study's aim and specify exactly what needs to be learned. Additionally, to address all user requirements, these research questions identify the important features of the proposed system.

Question 1: What is the web-based solution that can be given to solve the research problem?

Question 2: What kind of information should the system provide?

Question 3: What should be the most important functions of the proposed system?

Question 4: How to use novel concepts and technologies to increase efficiency, user-friendliness, and privacy?
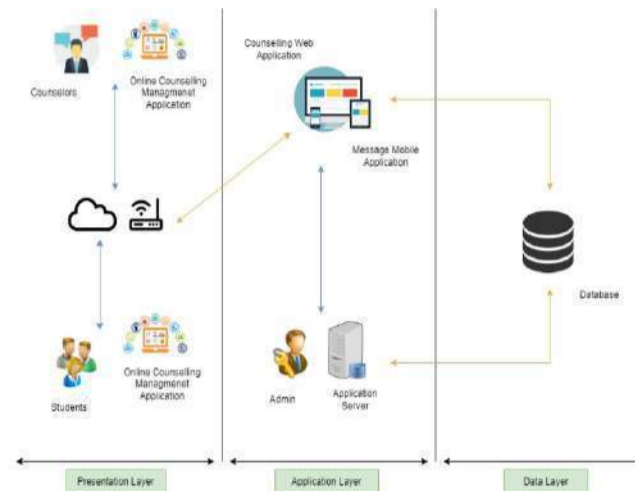
B. Proposed System Design

Figure 5: Overall System Architecture

Source: Author

1) Overall System Architecture: The overall architecture of the system and the relationships between the system's components are shown in Figure 5. Three layers - the presentation layer, the application layer, and the database layer make up the layered architecture that contains the architectural design.
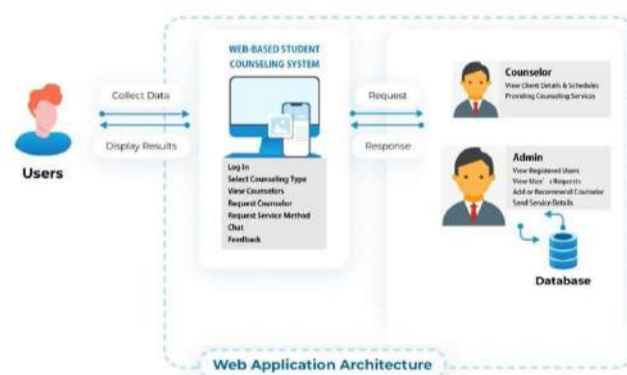
2) Modular Architecture:

Figure 6: Modular Architecture

Source: Author

C. Data Gathering

In developing a system, the stage of collecting related data and information is a very important and hard step. As mentioned above, KDU has a helpdesk system, but no such system has been introduced before to contact a counsellor through this kind of zoom technology and video conference.

During this data collection step, it was very difficult to connect with the students and find out what their problems, challenges, and needs were. It was also a difficult process to make time to meet them physically due to their busy schedules. Finally had to collect them through the questionnaire to gather the required information and it was a time-consuming process.

Through this questionnaire, the researcher was able to get an idea about the problems faced by the students and the domain of the system they expect in the data collection method. However, the KDU student counselling services will be able to manage, facilitate KDU students' pursuit of their academic and personal goals, protect student privacy, develop and enhance student potential, mental health, and well-being, as well as provide additional counselling services to prevent spending money on and provide an efficient and reliable service. Also, it's an advantage for them to get counselling services from their university rather than dealing with some outsources.

D. Technology Adaptation

Website Development: The main requirement according to the identified research problem is a standard database with details of students and counsellors. They're occurred doubt about whether a website or an android application is more appropriate. For this, the earlier mentioned google survey was used to ask the preferences of selected 80 students. The majority of them opted for a website over an android application. The website is implemented using the Laravel framework and node.js.

Database Architecture: When computerizing students' information, the next question was what specific information counsellors should know about students. Students can register into the system by filling out the registration form shown in Figure 7 and there collect information such as First name, last name, and email. Here the researcher decided to use a normal registration form.

Figure 7: Student Counselling Management System for KDU Registration Form

Source: Author

Figure 8: Student Counselling Management System for KDU Login Form

Source: Author

In the data-gathering phase, the techniques that have been used are google forms and interviews conducted over the phone. Regarding the collected data, the data of the students and the counsellor in the proposed system are stored in a MySQL database. Currently, there are 3 tables (Students Details, Counsellors Details, and Counselling Details) which will increase later.

4. Discussion

By use of virtual counselling expanded significantly in 2020 as a result of the COVID-19 virus. Many countries enforced quarantines due to the pandemic to prevent the virus from spreading further. As a result, mental health professionals were unable to meet with their client's face to face and were forced to rely on virtual counselling. And in the face of a crisis in the country, online counselling services became more popular to solve the mental problems of humans. Furthermore, the pandemic and ensuing quarantine made many individuals afraid and sad, leading

to a rise in the demand for mental health treatments.(Hashim *et al.*, 2013) Because virtual counselling became so popular during this time, its overall use has increased, even though the requirement for social distancing has decreased.

Student counselling is a critical component for students because it assists them in avoiding issues that may have a detrimental impact on their education. Students are under a great deal of stress and need to be heard, but they may not be able to express their concerns in front of counsellors because they do not feel comfortable speaking in front of them, and they also do not want to inform others that they are meeting with a counsellor. As a result, the need for an online system capable of managing all counselling operations was discovered. Even though many counselling management systems have been launched in the industry, they are not suitable for use in specific universities, institutes, or other institutions.(*BetterHelp - Help us match the right therapist for you*, no date)

The system basically focused on finding a suitable counsellor to help students find solutions to existing psychological problems and recommend treatment for them. For this, a web-based online counselling system is

Figure 9: Aware of psychological problems for students

Source: Author

introduced and the main points that led to its development were obtained from the students through a questionnaire. Based on the information obtained from a group of 80 students, a review of their problems was done. Figure 9 shows whether the students have a psychological problem or not as an overall percentage.
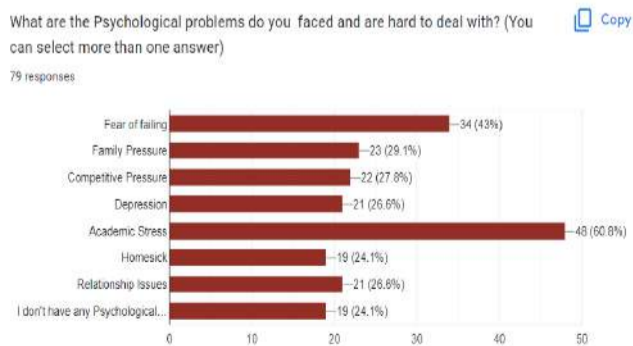

Figure 10: Common psychological problems

Source: Author

Figure 10 shows the initial rating and review of psychological problems faced and difficult to face by the students.

Figure 11 shows the reasons for KDU students didn't resort to counseling services even though they have psychological problems.
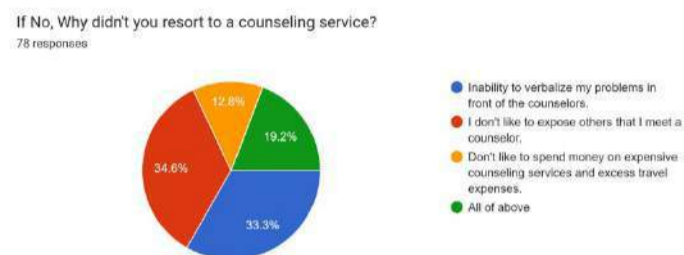

Figure 11: Reasons for not resort counseling services

Source: Author

Figure 12 shows the students' preference as an overall percentage to use an online counselling service in the KDU.
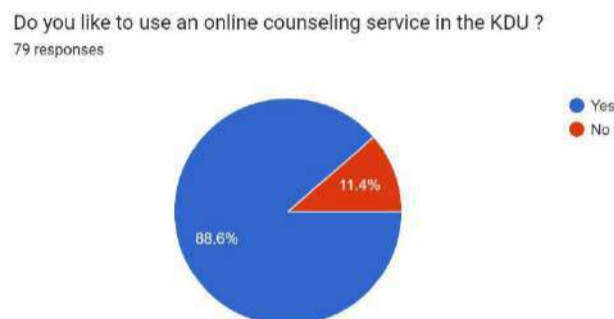
Figure 12: Preference to use an online counseling service

Source: Author

A chatbot is also designed to solve their mental problems so that the efficiency and accuracy of the proposed system are preserved as well as privacy. The chatbot enables students to have a private conversation about their mental health until the counsellor contacts them. Messaging also provides a mobile app so that the busy counsellor can answer students' questions at the same time they ask.

5. Conclusion and Future Works

KDU student counselling system will be able to manage, facilitate KDU students' pursuit of their academic and personal goals, protect student privacy, and develop and enhance student potential, mental health, and well-being, as well as provide an efficient and reliable service to avoid psychological problems for better academic performance.

The limitations of this system are it is only focused on counselling services in the KDU to limit the scope of the project. This system can be further improved by providing counselling services to university students all over the country.

Also, researchers can add more features to the system such as the ability to indicate the stress level through a smartwatch and assist them to reduce their stress by providing counselling services through the smartwatch and the mobile app. Stress level is a feature found on many Smartwatches allowing a user to determine their current level of stress based on their heart-rate variability. Also, Sinhala and Tamil can be added as navigation languages.

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Author Biography

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Multi-Criteria Group Decision-Making (MCGDM) for Verification of HydroGIS Model Development Framework

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Abstract: *Expert review is the best method for the verification of flood management frameworks. However, when verifying a building-block software framework for urban flood management HydroGIS model development (HydroGIS Framework), the framework is always subjected to more arguable or marginal acceptance, due to the development process is less observed by the expert evaluators and a higher possibility of localised thinking limited to experts' field of studies. Therefore, in such scenarios, the multi-criteria group decision-making (MCGDM) method gets popular as it mainly analysis the group of experts' view on a set of alternatives (options) following the same set of criteria. However, the MCGDM method directly does not support the present verification. Therefore, the present work aims to modify the MCGDM method for verification of the present HydroGIS framework. For that, it studied different works on MCGDM and formulate a general map of integrated processes. Then analyse the HydroGIS framework components' integration depths using spatial analysis method (area comparison) and attention theory explanation, to select a suitable fuzzy type to be used in MCGDM. After that present work map, the framework verification attributes to the MCGDM model and carry out the verification. As result, it developed a verified relation map of various fuzzy concepts, formulated a generalised process map of the MCGDM process, identified Type-1 fuzzy concept is substantial to expert preferences demodulation and demonstrated how it can employ modified MCGDM method to evaluate the urban flood management framework satisfactorily. The present work shows how MCGDM can be utilised for Flood management framework verification.*

Keywords*: Multi-Criteria Group Decision-Making (MCGDM), HydroGIS Tool, Urban Flood Management Framework, Fuzzy Concept, Expert Review*

multiple experts such as government administrators, water and civil engineers, land, town and city planners, policymakers, lawyers, socialists, economists and environmentalists. Then, based on the research articles on the components of the framework, it calculated the integration depths as shown in Figure 1. These integration depths varying from 0 to 5 (the number with decimal points on the arrow) denote the attention of the researchers on the components when developing the urban flood management model (0 denotes no integration, 1 denotes totally integrate). As well the components which are shown in the rectangles show the generalised components in a building-block software framework.
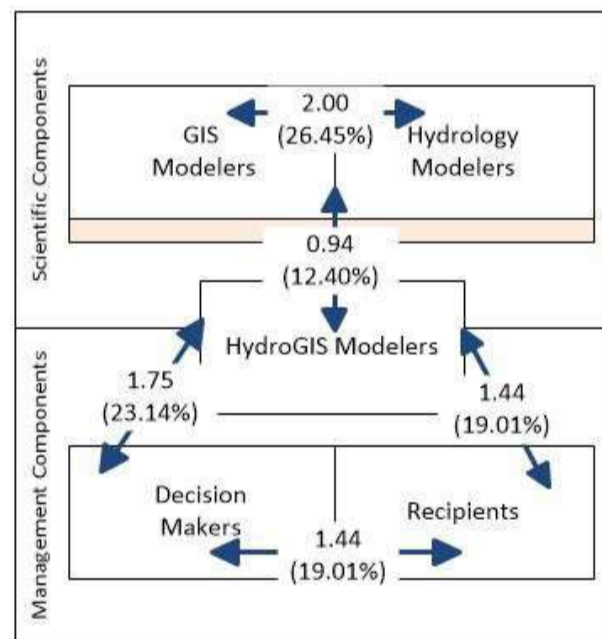
Figure 1: The Average Depth of Investigation in Each Integration and its Comparison Level as a Percentage
Source: (Pradeep & Wijesekera, 2021)

1. Introduction

The early work of the authors developed the urban flood management HydroGIS model development framework which can be utilised by the software professional (Pradeep & Wijesekera, 2021). It is categorised under the building-block software framework category (Pradeep & Edirisuriya, 2021) where the transdisciplinary approach is highly employed in development. The development of the framework, syntheses the knowledge and experiences of

Flood Management Framework Verification

The practical implementation of flood management frameworks and analysis of its outcome are time-consuming. Hence, most researchers evaluate the developed frameworks through expert review (Malalgoda et al., 2013; Molinari et al., 2017, 2018). However, foresaid HydroGIS model development framework is a suggested solution through an abductive theory approach with interpretivism philosophy. Due to this phenomenal continuum, the solutions may be subjected to more arguable as the development process is

less observed by the expert evaluators and higher possibility of localised thinking limited to the own field of study (Lane et al., 2020). Specially, as the solution is suggested to integrate multiple disciplines which inherently creates conflict in the epistemic values, the marginal acceptance of the framework is predictable (Huutoniemi, 2010; MacLeod, 2018).

A. Multi-Criteria Decision-Analysing (MCDA)

Therefore, in such a scenario, if it gets the expert reviews and analysis them using symmetrical methods such as correlation and coefficient of determinations may misinterpret the real feeling of the evaluators and ignores the influences of different knowledge depending on the factors (Woodside, 2013). Further the demodulation of individual analogue reviews (preferences) to digital may distort the real mood of the preference. Therefore, as MCDA evaluates the different evaluators' opinions, the present work studied the different MCDA methods and found that multi-criteria group decision-making (MCGDM) is interesting to present work. MCGDM mainly analysis the group of experts' views on a set of alternatives (options) under the influence of the same set of criteria. When considering the HydroGIS model development framework, the framework and its components' integration depths may be evaluated by different experts heterogeneously. Therefore, due to the power of MCGDM to settle the conflicting decision-making criteria and synthesis the processes of different individual experts (Morente-Molinera et al., 2020; Naim & Hagras, 2014), it identified that MCGDM is the best-suited method for analysis the experts' reviews on the developed framework. However, there is no direct guideline for utilising MCGDM in the same work.

A. Aim

Therefore, the present work aims to study the MCGDM methodology and employ it for HydroGIS model development framework verification.

2. Analysis

A. Multi-Criteria Group Decision-Making (MCGDM)

When studying the MCGDM, it found that there are number of different employments of the method. Then, it studied the works of Naim and Hagras, (2014), Çağman and Karataş, (2013), Das, Kar and Pal, (2014), Rahman et al., (2021) and Morente-Molinera et al., (2020) and observed that those are tailored developed based on the individual requirement of the study. Then the present work generalised the inputs, processes and outputs of those methods and identified 7 components in the processes as shown.

In this generalised MCGDM scenario, the preferences of a group of experts on a set of alternatives are evaluated to make a final decision. Then in the process, a number of experts (1 in Figure 2) are expressing different preferences

(2 in Error! Reference source not found.) on the alternatives or solutions available (3 in Error! Reference source not found.). However, the experts' preferences are influenced by different criteria (4 in Figure 2 Error! Reference source not found**.**). Then either analysing a simple expert review or employing an individual fuzzy logic-based method (6 in Figure 2) it attempts to generalise the final decision as a ranked list or prioritized item of alterative/s (7 in Figure 2). Then when considering the employed fuzzy logic-based method, evaluated works presented different methods such as single-valued neutrosophic (SVNS), interval neutrosophic (INS), and interval-valued intuitionistic fuzzy (IVIFS) which the attention of the present research was grabbed.
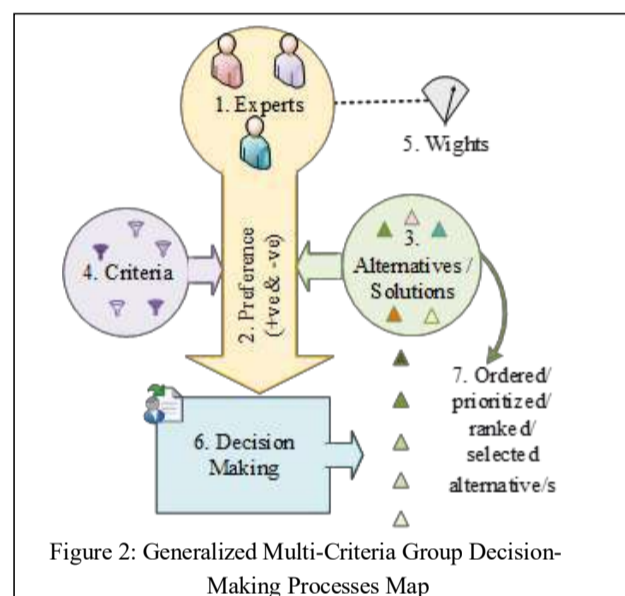
Figure 2: Generalized Multi-Criteria Group Decision-Making Processes Map

B. Integration of Fuzzy Concept

Then it studied the role of the fuzzy concept in MCGDM and found that to reduce the demodulation-distortion that happens in expert review analysis, it utilises the knowledge of the fuzzy concept as the fuzzy concept evaluates all possible indicators to measure the level of preferences in multicriteria affecting situations (Sahani et al., 2019). Then it carried out a study on the concept and found that there are 6 methods which are based on type-1, type-2, Hesitant, Intuitionistic, Neutrosophic or Plithogenic fuzzy concepts (Kaya et al., 2019; Smarandache, 2018). The evolution of concept is described differently, hence it developed a generalised flowchart of the concept building. It contacted the two last contributors of evolvement and got the views for the flowchart. Then it developed a fuzzy concept evolvement flowchart as Figure 3 shows.

1) Fuzzy Concept for decision making: However, when considering the decision-making method in MCGDM (6 in Figure 2) it could observe that MCGDM untiled several customised methods based on fundamental fussy methods which evolved from Type-1 fussy method. In Type-1, it

considered the membership function of the preferences (based on a mathematical model) and in the next development, Type-2 considers the membership function as

Figure 3: Extensions and relations of fuzzy concepts
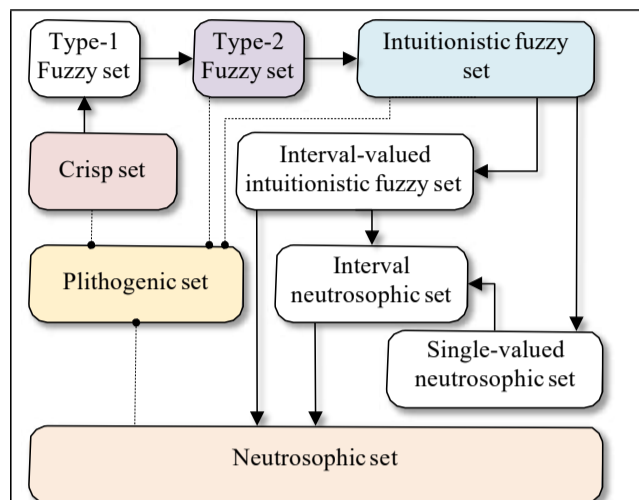Source: adopted from Alcantud (2018, p.4), Smarandache (2018) and Kaya, Çolak and Terzi (2019)

a fuzzy set (based on a logical model). Then in type-2 situation, it developed the sequence of fuzzy set operations based on the individual criteria.

For example, if decision-makers think, "Learning" and "Teaching" both must be there to influence the student's "Creativity", the assigned fuzzy values of "Learning and Teaching" for a particular student need to be multiplied (fussy multiplication) to get the value for creativity. And in other ways of thinking, say either "Learning" or "Teaching" can influence "Creativity", then it must employ fuzzy summation. Further, in Type-1, "Learning" and "Teaching" have individual real values varying between 0 and 1. Type-2 is also exactly the same but due to the multiple experts, the real values become a set, and, in each row, all the criteria may not appear, i.e. some experts believe only "learning" is enough for "creativity" while others believe are both required. Such various situations are further described as soft sets and hypersoft sets.

Then when it moves to more advanced intuitionistic fussy methods, the non-membership function is also considered. The intuitionistic concept enhances the result accuracy by not only including the preferences of the experts (membership function), but also the agony of the alternatives (non-membership function). Further, the researchers have included the foresaid **hesitant** function to represent the uncertainty between membership and non-membership degrees. Hesitation became a base for other interest development of a fussy concept called Neutrosophic fuzzy. It can be seen as a combination of *intuitionistic* with *hesitation*, but it generalises the intuitionistic fussy set to true membership, intermittency and false–membership.

Then the concept is moved towards Plithogenic fuzzy, and the degree of appurtenance of the elements is encountered. As shown in Figure 3, the Plithogenic concept pay concern

the degree of appurtenance for each and every attribute of each member. Then when considering the same example of "Learning" and "Teaching", all other methods carry out an operation based on a crisp, fuzzy, intuitionistic or neutrosophic set used to find a single value for a student. But when Plithogenic sets, it does not carry out any operation and shows each assigned attribute value separately for "Learning" and "Teaching" for a student.

*2) Selection of Fuzzy logic for the present work***:** Then the present research has understood that the fussy logic base method (6 in Figure 2) can be customised according to not only the variable requirements but also to the level of accuracy it predicts. Hence it needed to decide the level of evaluation accuracy of the developed framework which is going to evaluate in this study. For that it mapped the present developed framework components in a scaled 2-D cartesian plane, converting the integration depths to spatial distances using GIS software. The distances between the components were calculated using the values indicated in the final framework (Figure 1). There, the values are varying from 1 – very low to 5-very high. Then when mapping those, it considers that the closeness (the integration depth) should be visualised inversely, i.e the closer objects are placed closer to each other. Hence, it recalculated the inverse of the depths using Eq. 1. The developed map with a demonstration of each component's review depths is shown in Figure 4.

$$R \quad i \quad i \quad a \quad = 5 - I \quad g \quad a \quad i \quad D \quad h \quad (1)$$

Where
Review distance$_{ij}$ = Integration depth distance between i^{th} and j^{th} components
Integration Depth$_{ij}$ = Integration depth of ith and j^{th} components
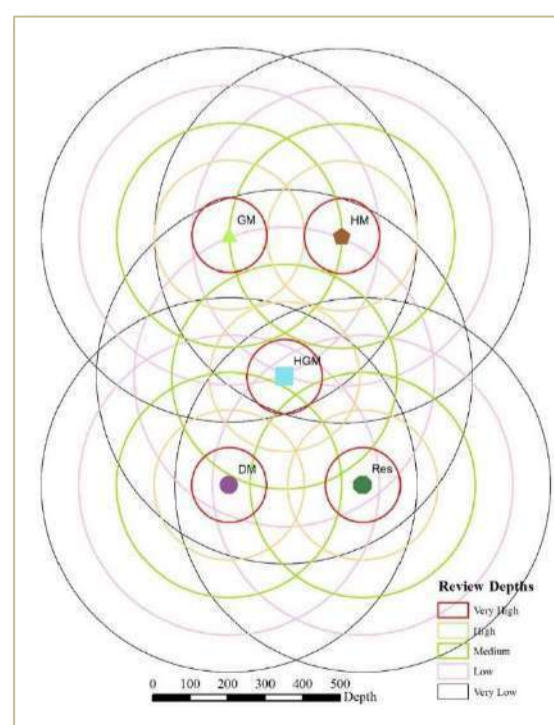
Figure 4: Spatial Demonstration of Components'
Deployment

The different coloured circles shown in Figure 4 illustrate
the theoretical viewshed of each component. For example,
the areas belonging to "Very High" and "High" circles of
GIS modellers (GM) do not contain any other component.
But the Hydro Modellers (HM) are placed on the "Medium"
circle of GM. That means GMs considered the HM in
medium level importance when they make their decisions in
flood management. Figure 5 shows only the circles where
such conditions are satisfied.
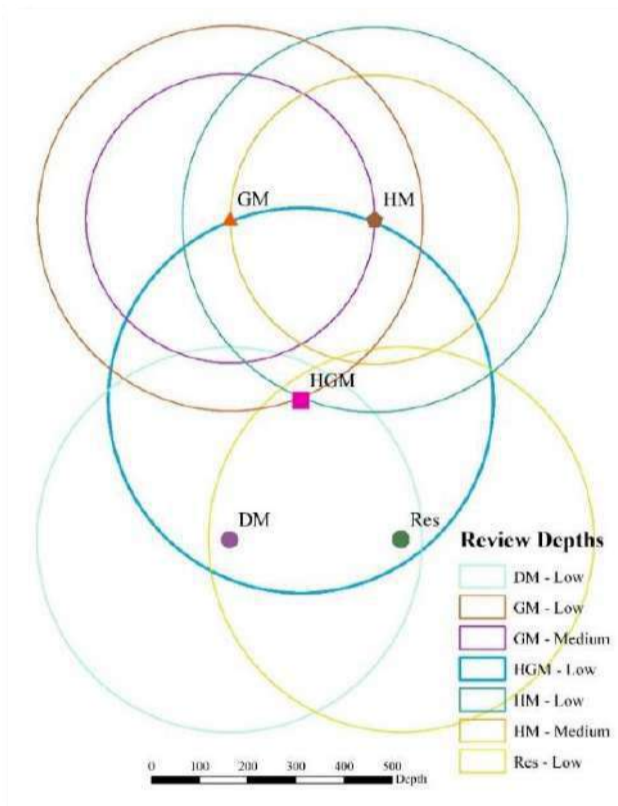
Figure 5: Overlapping of review depths

Using the extracted data shown in Figure 5, it created a 3-D
map. To highlight the places where GM, HM, HGM, DM
and Recipients are situated, it created tiny areas for each of
them and labelled them as "very high". This creation is
based on the hypothesis that, each of them (GM, HM, HGM,
DM and Recipients) are studying their subject area at a
"very high" level when they decide on flood management.
Based on such areas, it created Triangular irregular
networks (TIN), where the heights are taken from the
marked circles. The two views of TIN are shown in Figures
6 and 7.

The 3-D view shown in Figure 6 demonstrates a clear
departure of one study area from others and always others
falling in areas of "medium" or "low" interest levels. As
well according to Figures 7 and 8, it can observe that there
is a very small area with very high and very low-level

review depths. As well most of the areas are covered by the
"Low" while a moderate area is belonging to "Medium".
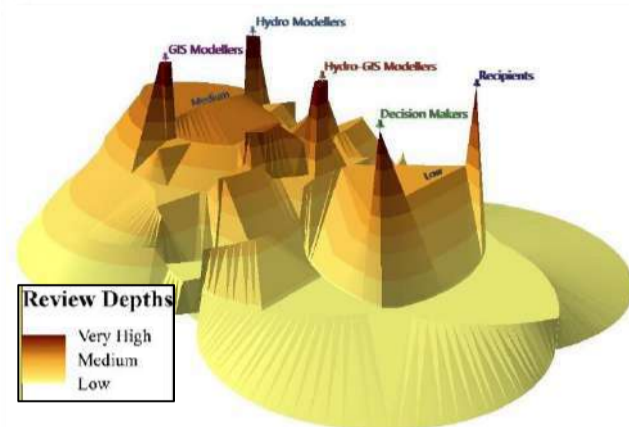
Figure 6: 3-D View of the review depths (Inversed to
hights)
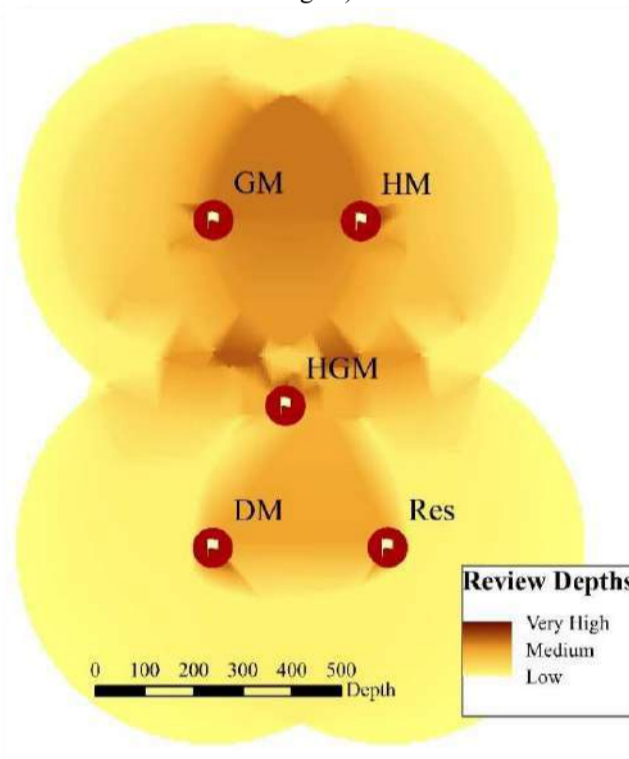
Figure 7: Cumulation of all review depths
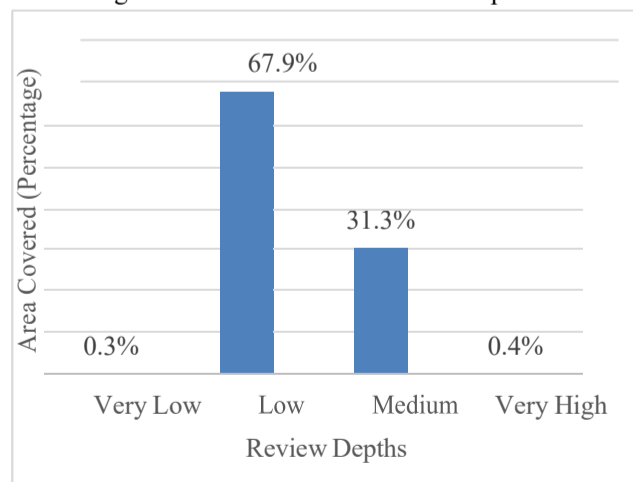
Figure 8: Comparison of review depth area distribution

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3) Attention and Attention Schema Theories

Therefore, it is more arguable to translate the above finding as, "the stakeholders in the full understanding of their own taught area but with low attention on the areas where they have not learnt". However, this hypothesis has proved, and such an attitude of the people is described using attention theory. According to the theory, when people learn new knowledge, they utilised the taught knowledge as the trusted base source and consider the new knowledge as an extension of such taught knowledge (Huang & Sherman, 2018). Due to this mentality, the individual stakeholder in the flood management proces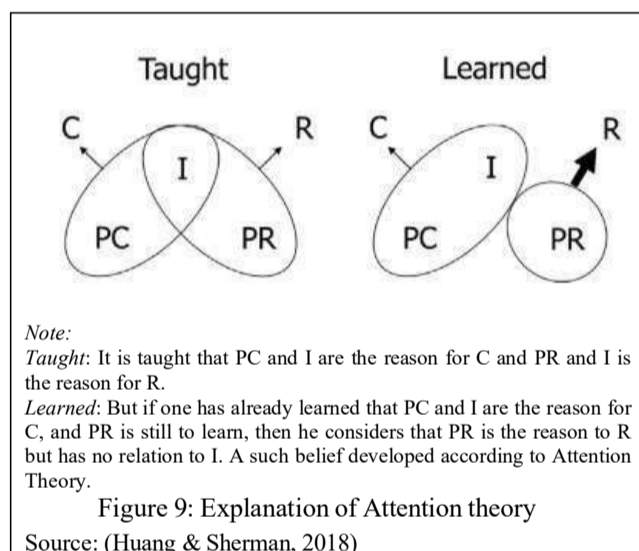s is believing the rest of the knowledge is built on its own subject area. Therefore, when commenting on such an unknown thing, there is a higher possibility to give lesser importance to *new knowledge* than own (Figure 9).


Note:
Taught: It is taught that PC and I are the reason for C and PR and I is the reason for R.
Learned: But if one has already learned that PC and I are the reason for C, and PR is still to learn, then he considers that PR is the reason to R but has no relation to I. A such belief developed according to Attention Theory.

Figure 9: Explanation of Attention theory
Source: (Huang & Sherman, 2018)

Nevertheless, in some situations, the reviewer claims that "I have a subjective experience of *new knowledge*". Then according to the Attention Schema Theory, this awareness is a piece of information, and the reviewer started to believe that he also knows the level of importance of a *new knowledge* area (Graziano, 2013, p. 29).

4) Expert Review Explanation

As an example, imagine a GIS modeller (GM) who has been in flood management for decades, and is going to comment on the importance of Decision Makers (DM). According to his experience, the DM is implementing the developed model, but the development of a such model scientifically as well as accurately is the most important and difficult work. Then according to the GM, flood management is his own work, but DM is new learning based on his work (attention theory). Further with experience, GM knows the DM is a simple implementation of the hardly developed model which appears everywhere (Attention Schema Theory).

With this attitude of the GM, there is a high chance of commenting the DM integration as a less important requirement in urban flood management than GIS modelling (Figure 10).

Hence due to this Attention and Attention Schema Theory applicability, it can predict that the professional comments to be taken to the framework evaluation, will be having most of the time positive attitude towards the other knowledge areas, but rarely expect negative feedback. Then, it can argue that fuzzy values of the expert preferences are justifiable to have only the membership function where it appears in the Type-1 fuzzy concept.

Figure 10: Attention and Attention Schema Theory Application in HydroGIS Model Development Framework
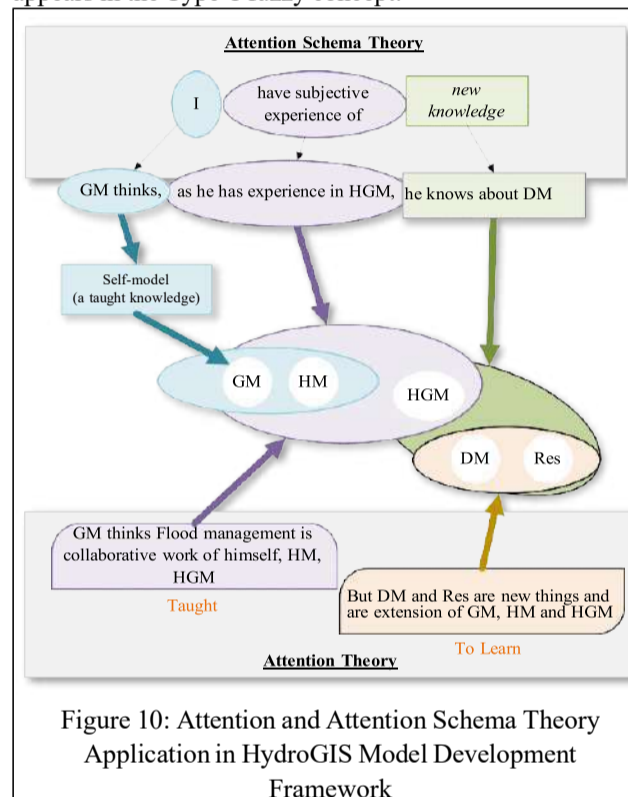
II. Application of Mcgdm

A) Evaluation Criteria and Questionnaire Development

The developed *HydroGIS* framework was required to be reviewed to find the (1) adequacy for the utilisation, (2) satisfaction with the representativeness, and (3) need & use with the merits & demerits. Then those become the main evaluating points and set the questionnaire's questions aligned with those. The questionnaire was developed following a repetitive development method (Pradeep & Wijesekara, 2019). The details of the main review points, sub-review point, question/statement and answer structure, of the questionnaire, are shown in Table 1. The final version of the questionnaire was developed as an online google form. The questionnaire was electronically distributed among over 5000 potential experts in Hydrology, GIS, HydroGIS modelling, Computing and Decision-Making. It followed the Respond Driven Sampling method and collected 70 responses. As the equal percentage of experts in each expert area, carrying substantial experiences and education

qualifications, it is considered that the sample is representative.

Table 1: Evaluation Criteria and Question Mapping

Main review point	Sub review point	The Question/statement	Answer Structure
Adequacy	1. On Components	i.Do you feel all the required components are included in the framework?	1-3 Likert Scale or Comment
	2. For tool development	ii.Do you feel all the integrations (not the percentages) in the developed framework are appropriate for developing better tools?	1-3 Likert Scale or Comment
Satisfaction	3. Over present arraignment	iii.The percentage of integration found through research (xx%) is accurate (for each separately)	1-7 Likert Scale
	4. On degree of integration	iv.This integration is highly required (for each separately)	1-7 Likert Scale
		v.This is a very important integration	1-7 Likert Scale
Views on framework	5. Priority order of integration	vi.Mark the order of favour when considering all the 5 integrations	1-5 priority order
	6. Over present arraignment	vii.If you think the percentage found through research (xx%) should be different, then what should it be? (for each separately)	Open-ended
	7. Of completeness	viii.Please provide your views / opinions / ideas / critics on this integration (for each separately)	Open-ended
	8. Merits and demerits	ix.Describe any merits or/and demerits of the framework. Please give your suggestions too	Open-ended
	9. Need and Use	x.Please provide your views / opinions / ideas / critics on each integration	Open-ended

B) Mapping MCGDM steps

MCGDM is utilised to find the preference order of the Likert-scale questions and statements only. All other open questions were analysed using thematic analysis. Then the MCGDM which is shown in Figure 11 is employed for each sub-review point and data were accumulated to get the view for the main review point.

1) Experts: The present work selected 68 reviews of the participants (hereafter experts) after excluding the unrealistic answers.

Figure 11: Map of present work activities to MCGDM activities
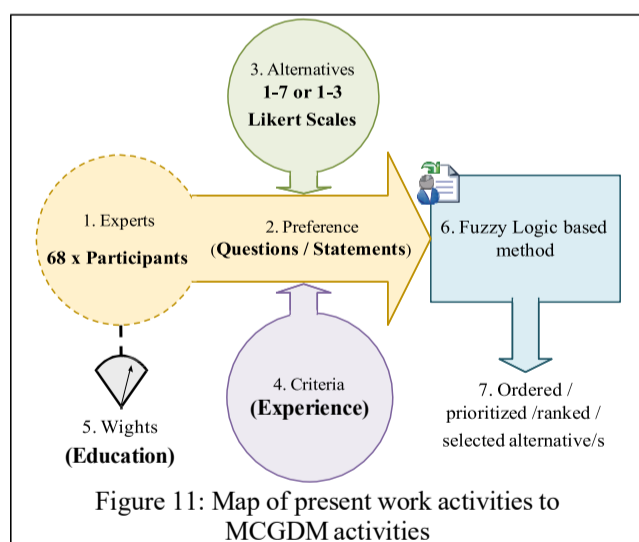
2) Alternatives and Preferences: Each expert selected one of the alternatives for each question/statement (sub-review point) as the preference. For example, consider the statement "Percentage of integration found through research is accurate". Then the expert has 7 alternatives to be selected, (1) Completely Agree, (2) Mostly Agree, (3) Slightly Agree,

(4) Undecided, (5) Slightly Disagree, (6) Mostly Disagree, and Completely Disagree (7).

3) Criteria and Weight: Then each preference needs to be evaluated under the criteria in the MCGDM process. However, when considering the present scenario, the expert's preference decision depends on the particular person's knowledge. However, the knowledge cannot be taken directly as well as for the present work, the person should be aware of multiple subject areas thoroughly and equally. However, through the data set, it found that majority of the experts are having experience in non-expert areas at different levels, while the education is also above bachelor's level. Then it is important to identify the criteria which affect the decision-making. Hence when considering the previous studies (Dewey, 1986; Fuller et al., 2017; Klein, 1999; Rosenberger, 2020), education and experience there are influence decision-making. Specially, it has been realised that in field decision-making processes like medicine and engineering, education cannot be replaced with experience as in-depth learning from education is important in decision making. Therefore, the present work considers that both education and experience govern the accurate decision in flood management too. Hence "Both/And – (equally important and must)" situation exists in the education and experience evaluation. Therefore, to weight the expert, it utilised the expert's education and experience utilised as a decision-making criterion for the MCGDM process. Hence, the individual years of experience are categorised into a fuzzy value using Table 2 and average experience is taken for all areas which interested in the present work (Table 3).

Table 2: Score of the Experience Period

Assigned fuzzy value for experience (ex_n)						
> 20 years	15 to 20	10 to 15	5 to 10	1 to 5	< 1 year	No Exp
1.00	0.83	0.67	0.50	0.33	0.17	0.00

Table 3: Final weight of Experience

Experience in	The assigned score for experience
GIS	ex_1
Hydrology	ex_2
Land management	ex_3
Town and country planning	ex_4
Public admin	ex_5
Flood related decision making	ex_6
Software development	ex_7
Data handling/ analysing	ex_8
Construction	ex_9
Pub water management	ex_{10}
Pvt water management	ex_{11}
Other	ex_{12}
Weight of the Experience (E_{ex})= Average (ex_1 to ex_{12}) where $ex_n > 0$	

In the same way, it scores the education of the expert as shown in Table 4.

Table 4: Score of the Highest Education Qualification

Assigned fuzzy value for Weight the Education (E_{ed})								
Snr Prof	Prof	PhD	Mphil	Prof	MSc	PG	BSc	Sec. Edu
1	0.875	0.75	0.625	0.625	0.5	0.375	0.25	0.125

4) Fuzzy Logic Based Method: To prioritise the preferences, it is required to find a weighted list. Then instead of weighting the preference, each expert was weighted using Eq. 2.

$$\boldsymbol{E} = (\boldsymbol{E} \times \boldsymbol{E}) \tag{2}$$

Where
E_w : Expert's Weight
E_{ex}: Weight of the Experiences

E_{ed}: Weight of the Education

MCGDM was employed to evaluate 1 to 6 sub-review points (See 2nd column of Table 1). The first 4 sub-review points had 5 questions/statements and it asked the preference on the Likert scale. Then those preferences are prioritised according to the professional categories, following the flowchart shown in Figure 12. The values received to rank each preference were accumulated according to the main review point and computed in two priority lists for the main two review points, (1) Adequacy (Table 5) and (2) Satisfaction (Table 6).

The 5th and 6th sub-review point questions asked for (1) Mark the priority being given to integrations in framework components according to the preferences and (2) insert the preferred integration percentages for each % value shown in Figure 1. To find the different priorities assigned to the different integrations it utilised Eq.3. Results are shown in Table 7.

$$WAI = \frac{\sum P_i \times E_w}{\sum E_w} \tag{3}$$

Whare

WPI_i = Weighted priority order number for i^{th} integration
P_i = Expert Preferred priority number for the integration which varies from 1 (minimum) -5 (maximum)
E_w = : Expert's Weight (see Eq.. 2)

For find the experts preferred integration percentages for it utilised the Eq.4. Results are shown in Table 8.

$$WPI = \frac{\sum A_i \times E_w}{\sum E_w} \tag{4}$$

Whare

WAI_i = Weighted percentage for i^{th} integration
A_i = Expert Preferred Percentages for the individual integration
E_w = : Expert's Weight (see Eq.. 2)

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Figure 12: Flowchart of Priority order
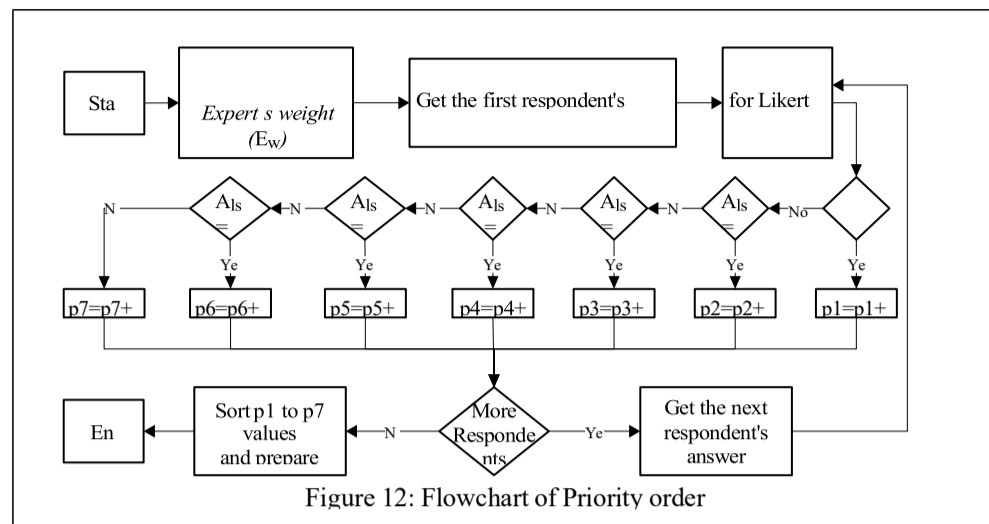
Table 5: Prioritised List of Preference for Adequacy of Framework - MCGDM Calculation

Option	Adequacy				Final Adequacy
	DM	GM	HGM	HM	
Completely Agree	1.25	1.65	7.12	0.34	10.37
Mostly Agree	1.38	2.34	0.68	2.73	7.13
Slightly Agree	0.26	0.66	1.76	0.06	2.75
Undecided	0.00	0.33	0.21	0.00	0.54
Slightly Disagree	0.00	0.00	0.00	2.04	2.04
Mostly Disagree	0.00	0.05	0.00	0.00	0.05
Completely Disagree	0.00	0.00	0.00	0.19	0.19

Note:
DM: Decision -makers
GM: GIS Modellers
HGM: HydroGIS / SW Modellers
HM: Hydro Modellers

Table 6: Prioritised List of Preference for Satisfaction of Framework - MCGDM Calculation

Option	Satisfaction				Overall satisfaction
	DM	GM	HGM	HM	
Completely Agree	7.17	17.97	26.64	14.41	66.19
Mostly Agree	7.98	11.03	29.25	7.51	55.77
Slightly Agree	3.40	4.73	8.09	2.71	18.93
Undecided	2.01	6.00	2.44	5.49	15.94
Slightly Disagree	1.65	1.89	1.51	2.21	7.26
Mostly Disagree	0.52	3.00	5.33	7.90	16.75
Completely Disagree	0.00	0.05	0.08	0.00	0.13

Note:
DM: Decision -makers
GM: GIS Modellers
HGM: HydroGIS / SW Modellers
HM: Hydro Modellers

C. Simple Calculation

The same calculation process was applied to the same dataset without utilising the fuzzy weight on the experts and preferences (same MCGDM steps without using the fuzzy criteria). Table 9 to 12 shows the simple calculation results which are consecutively the same as Table 5 to 8.

Table 7: Preferred Priority Order Assigned to Different Integrations by Experts in Different Professional Categories – MCGDM Calculation

Professional Category	The priority order given by the experts				
	Hydro Modelers and GIS Modelers	Hydro and GIS Modelers and HydroGIS-Modelers	HydroGIS-Modelers and Decision-Makers	HydroGIS-Modeler and Recipients	Decision-Makers and Recipients
Decision Maker	4.01	3.03	3.39	3.29	4.39
GIS Modeller	4.47	4.43	4.24	3.59	3.83
Hydro-GIS Modellers	4.54	4.34	4.11	3.73	4.23
Hydro Modellers	3.47	3.65	3.94	4.07	3.97
All participations	4.22	4.04	4.01	3.72	4.10

Table 8: Preferred Integration Depths of the Experts in Different Professional Categories - MCGDM Calculation

Professional Category	The expert thinking depths of the integration should be (%)				
	Hydro Modelers and GIS Modelers (26%)	Hydro and GIS Modelers and HydroGIS-Modelers (12%)	HydroGIS-Modelers and Decision-Makers (23%)	HydroGIS-Modeler and Recipients (19%)	Decision-Makers and Recipients (19%)
Decision Maker	13.41	13.54	10.29	25.41	37.35
GIS Modeller	45.38	13.36	11.70	10.30	19.27
Hydro-GIS Modellers	30.42	17.48	19.57	16.37	16.15
Hydro Modellers	22.91	19.07	20.29	23.88	13.85
All participations	29.13	16.49	16.76	18.51	19.11

Table 9: Prioritised List of Preference for Adequacy of Framework – Simple Calculation

Option	Adequacy				Final Adequacy
	DM	GM	HGM	HM	
Completely Agree	11.00	12.00	21.00	5.00	49.00
Mostly Agree	17.00	11.00	7.00	23.00	58.00
Slightly Agree	3.00	5.00	3.00	4.00	15.00
Undecided	0.00	2.00	1.00	0.00	3.00
Slightly Disagree	0.00	0.00	0.00	3.00	3.00
Mostly Disagree	0.00	1.00	0.00	0.00	1.00
Completely Disagree	0.00	0.00	0.00	1.00	1.00

Table 10: Prioritised List of Preference for Satisfaction of Framework - Simple Calculation

Option	Satisfaction				Overall satisfaction
	DM	GM	DM	GM	
Completely Agree	76.00	102.00	108.00	75.00	361.00
Mostly Agree	73.00	75.00	76.00	91.00	315.00
Slightly Agree	34.00	26.00	29.00	48.00	137.00
Undecided	28.00	34.00	13.00	25.00	100.00
Slightly Disagree	22.00	13.00	5.00	13.00	53.00
Mostly Disagree	7.00	19.00	8.00	18.00	52.00
Completely Disagree	0.00	1.00	1.00	0.00	2.00

Table 11: Preferred Priority Order Assigned to Different Integrations by Experts in Different Professional Categories – Simple Calculation

Professional Category	The priority order given by the experts				
	Hydro Modelers and GIS Modelers	Hydro and GIS Modelers and HydroGIS-Modelers	Hydro Modelers and GIS Modelers	HydroGIS-Modeler and Recipients	Hydro Modelers and GIS Modelers
Decision Maker	4.06	3.44	3.44	3.31	4.19
GIS Modeller	4.56	4.39	4.11	3.39	3.61
Hydro-GIS Modellers	4.50	4.25	4.19	3.69	4.44
Hydro Modellers	4.39	4.11	3.72	3.72	3.67
All participations	4.38	4.06	3.87	3.53	3.96

Table 12: Preferred Integration Depths of the Experts in Different Professional Categories - Simple Calculation

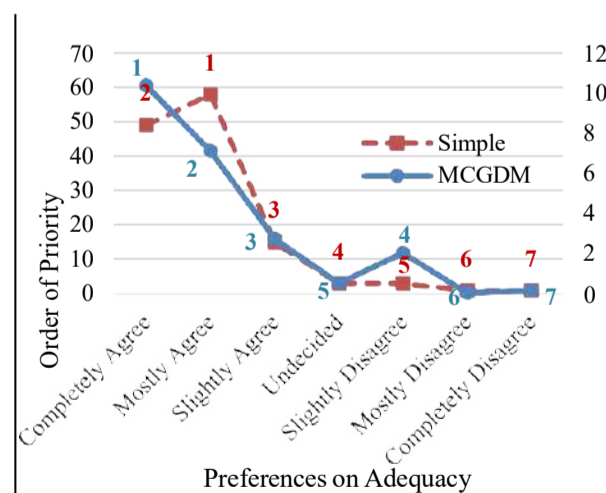| Expert	The expert thinking depths of the integration type (%)				
	Hydro Modelers and GIS Modelers (26%)	Hydro and GIS Modelers and HydroGIS-Modelers (12%)	HydroGIS-Modelers and Decision-Makers (23%)	HydroGIS-Modeler and Recipients (19%)	Decision-Makers and Recipients (19%)
Decision Maker	18.60	18.95	12.83	19.52	30.10
GIS Modeller	35.91	14.51	14.76	13.72	21.10
Hydro-GIS Modellers	22.39	11.49	26.60	20.89	18.62
Hydro Modellers	30.88	16.56	18.12	23.08	11.36
All participations	27.37	15.63	17.65	19.41	19.93

D. Comparison of MCGDM and Simple calculation outputs

The comparisons of MCGDM calculation outputs between with-fuzzy weights and without-fuzzy (simple) are shown in Figures 13 to 15.

When considering the MCGDM result of the priority list of the adequacy preferences on the framework, it shows that the "Completely Agree" preference wins but in simple calculation the "Mostly Agree" wins. As well, the preference for satisfaction also shows priority order differences in "Undecided, Slightly Disagree and Mostly Disagree" alternatives.

Apart from that, when considering the differences between results of MCGDM and non-weighted methods, the priority calculated for each integration type is the same (Figure 15), As well when considering the preferred integration depths for each integration type (Figure 16), they differ from each
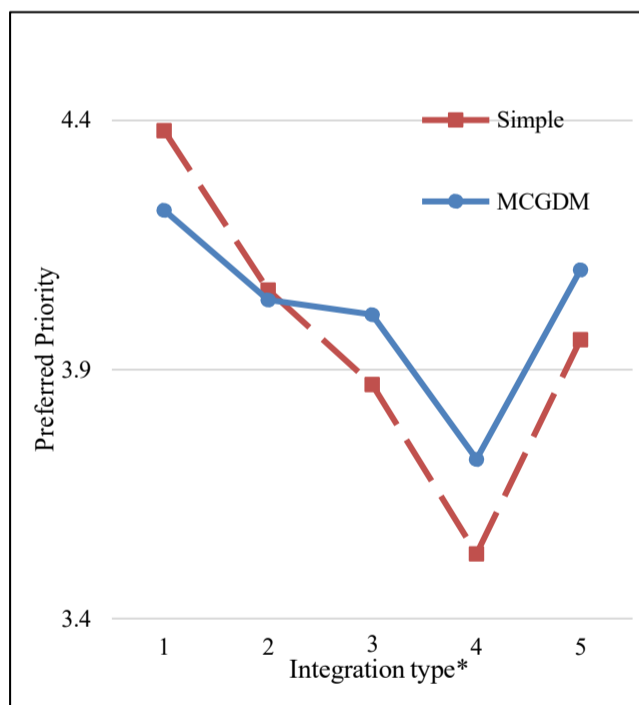
other only by 0.82% (min) – 1.72 %(max) only. Hence, there is not any significance in the results for both analyses.
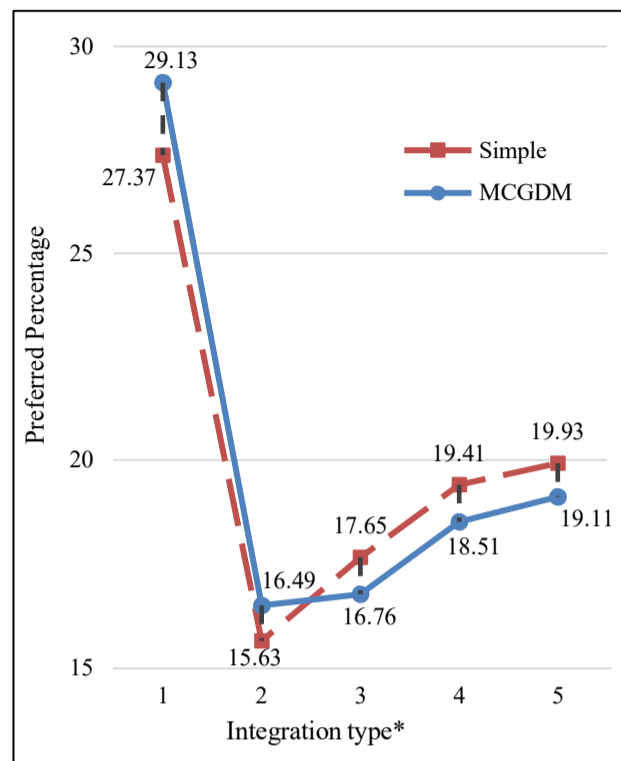

Note: Numbers on the nodes show the priority
Figure 13: Comparison of Adequacy Results
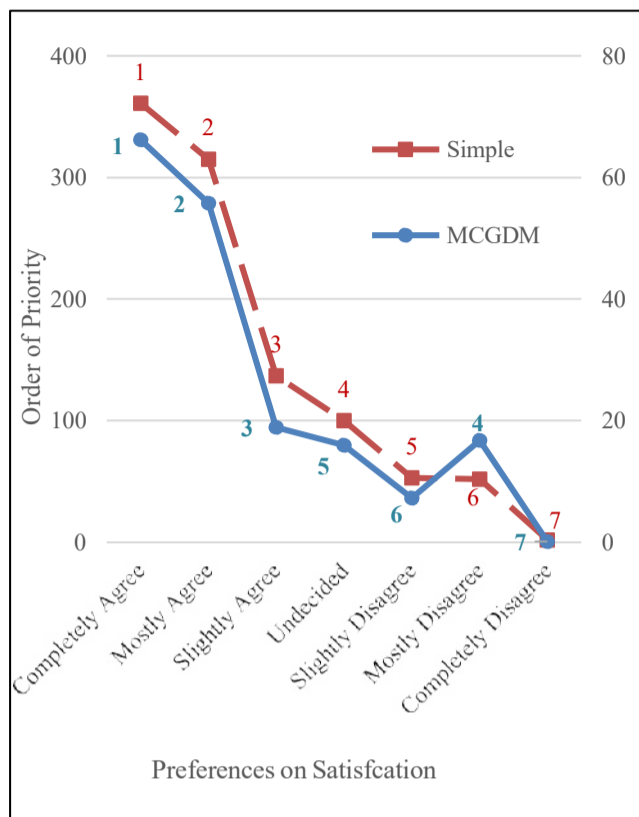
Note: Numbers on the nodes show the priority number
Figure 14: Comparison of Satisfaction Results

Note: *See Figure 15 note for Integration type descriptions
Figure 16: Comparison of Preferred Percentages for each Integration

Note: * Integration type numbers denote.
 1: Hydro Modelers and GIS Modelers
 2: Hydro and GIS Modelers and HydroGIS-Modelers
 3: HydroGIS-Modelers and Decision-Makers
 4: HydroGIS-Modeler and Recipients
 5: Decision-Makers and Recipients
Figure 15: Comparison of Priority Results

3. Result and Discussion

The present work attempted to select a suitable evaluation method for verifying the HydroGIS model development framework due to the intended framework demonstrating transdisciplinary stakeholders and activities to the software professionals to understand and construct sustainable urban flood management tools. Speciality in this evaluation is, that it required the reviews of not only the software professionals but also the other experts in the related disciplines. Due to the symmetrical methods distorting the real emotions of the reviews, the present work selected the MCGDM method which is in the MCDA family as the previous works proved the applicability of such in flood-related research. As the methodology has been practised in different approaches it summarised and construct a generalized MCGDM process map (Figure 2).

As the MCGDM heavily employed the Fuzzy concept in the analysis, the present work developed a verified map of different fuzzy logics and their relations (Figure 3).

The fuzzy logic types are employed based on the expected accuracy resolution, then, the present work analysed the accuracy requirement through 2D and 3D spatial analysis and the attention and attention schema theory. Finally, it selected Type 1 fuzzy concept as sufficient for the work.

The application of MCGDM is demonstrated with HydroGIS framework evaluation. for that, expert reviews were collected via a systematically developed questionnaire based on the main three review points, accuracy, satisfaction and Views on the framework. The data were analysed using the fuzzy weighted MCGDM method and simple method without using the fuzzy criteria. The comparison shows that

MCGDM effectively demonstrates the qualitative preference variations among the population than the simple method. However, when the questions are based on the quantitative value expressions, Fuzzy based MCGDM and simple method result differences are less significant.

When considering the HydroGIS framework evaluation, it shows that experts mostly agreed with the adequacy of the framework to their work and completely agree with the satisfaction of the components in the framework.

4. Conclusion

The present work is able to successfully modify and employ the MCGDM method for HydroGIS framework verification satisfactorily as calculations result substantially illustrate the real emotions of experts.

Even though there is a more complex fuzzy concept availed, the researchers should pay attention to selecting suitable fuzzy concepts systematically. The present work demonstrates how to employ spatial analysis and attention theory for systematic selection.

Finally, the developed HydroGIS model development framework is accepted by the experts as a framework which adequately develops for its own utilisation and satisfactorily represents the real world.

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AuthorBiography

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A review on the application of Artificial Intelligence in the Fashion and Apparel Industry

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Abstract: Dressing or clothes is a fundamental need of human beings that do not have a particular gender. Fashion design is a very demanding industry that involves many of the concepts, requirements, and demands of human beings. An area like this, which has a huge involvement of people requires some sort of technology to solve its problems and give the best service to the consumers. So, like every other industry, the fashion and Apparel industry also has some issues such as high production costs, wastage, customer dissatisfaction, and environmental pollution. In order to address these issues, Artificial Intelligence based technologies have been used, including Machine Learning, Decision Support systems, Expert Systems, Optimization, and Image Recognition & Vision. This review presents different research on Artificial Intelligence-based technologies and issues related to the fashion industry. Based on the operational procedures, this study's concerns are also divided into four areas, such as apparel design, production, retail, and supply chain management. In addition to that, Big data helps Apparel e-commerce retailers provide personalized offerings to customers. Machine learning and image processing techniques are commonly used to develop data-driven solutions using product-related data provided by Apparel product manufacturers & designers, and also these technologies help the supply chain to improve business operations.

Keywords: Fashion designing, Artificial intelligence, big data analytics

1. Introduction

Fashion and Apparel is one of the largest growing industries helping the economy, 38% to the Asia Pacific, 22% to North America and 26% to Europe.[1] It has been discovered that Fashion and Apparel industry sales have a growth of 5.5% in Europe and 7.5% in the Asia Pacific.[2] Because of the overproduction and the number of products returns this industry has been named as one of the biggest waste producers globally. The main reason for the customers not being satisfied with the product is dissatisfaction with the colour, size, and style of the product. So, the industry needs to have a good idea of the customer requirements and needs in the manufacturing process. At the same time the manufacturing process should follow steps that do not harm the environment.

So, as mentioned the major problems faced by this industry are high production cost, wastage, environmental pollution, etc. So, to solve these the best solution is to use the latest technology as Artificial Intelligence. There has been a huge growth in the sectors of health, manufacturing and transportation sectors using Artificial Intelligence to solve their problems. When considering the Fashion and Apparel industry consists of a few stages, they are Apparel design, pattern making, forecasting sales production and supply chain management. They have a huge growth with globalization and digitalization. That is essential to improve supply chain processes like Apparel production, fabric selection, fabric inspection, distribution, etc. The speciality in this industry is that it has to be dynamically changed based on the customer demands and fulfilling the customers' requirements. So, it will be really helpful if there is some digital platform for requirement elicitation and collection. For this, we can use technologies such as Artificial Intelligence, big data analytics, machine learning and other available technologies. Even though there is a need for an AI-based solution, some of the companies in the industry still use tools based on classical algorithms. The review conducted demonstrates the categorization of research articles based on four Apparel industry operational procedures, named design of Apparel, manufacturing of Apparel, retailing and supply chain management. The research paper [3] was limited to Artificial Intelligence algorithms, "decision support systems" and "Intelligent systems" in the textile and Apparel supply chain. Another study [4] also considered the Data Mining and Machine Learning approaches used in this industry. But when studying deep inside it is clear that most of the studies conducted in this field have not mentioned the usage of Artificial Intelligence in the Fashion and Apparel industry. Therefore, that is important to have a further study on finding the AI techniques that can be used to improve the business operations in different supply chains. Furthermore, Fashion and Apparel industry supply chain stages have not been defined according to the business perspective yet by none of the studies. However, as AI technology has expanded, the sophistication of commercial operations has increased. The current usage of Artificial Intelligence in the Fashion and Apparel industry comprehends the application of AI technology at various levels of this industry and grasps the use of AI technology from a commercial standpoint.

2. Research Famework

There are some methods involving the fashion and Apparel industry using Artificial Intelligence Technology. To make the study more reasonable, transparent, and consistent a method known as SLR methodology was used.[5] According to this research method the review process has been done by collecting and processing data from scientific databases. The articles were selected according to five phases known article retrieval, article selection, information extraction, article classification, analysis & funding and finally discussion & conclusion. Then those were taken into classification depending on the three research questions. The three research questions are "What has been the impact of Artificial Intelligence on the fashion industry over the last few decades?", "Where have AI technologies been used in the F&A supply chain?" and "To what extent has research addressed supply chain issues from a B2B and/or B2C standpoint?". There were three researchers known the first researcher, second researcher and expert researcher. The first two researchers are involved in the whole review process while the other is involved in the validation process. The competency of each researcher is mentioned below in Table 1.

Table 1. competencies of each researcher

Researcher	Competencies	
	Major	**Minor**
First Researcher	Artificial Intelligence, Data Science, Expert Systems, Machine learning	Fashion, Textile, supply chain, management
Second Researcher	Fashion and Apparel supply chain, fashion technology, information technology, data analysis	Machine learning, Artificial Intelligence
Third Researcher	Significant knowledge of both domains (AI and F&A)	NA

The article screening process consists of three main steps known as article retrieval, article selection and information extraction. The first step which is known as article review is the initial step of the selection process. So, it requires selecting the databases to conduct the research. Some of the well-known databases are Scopus and Web of Science. Then the other step is article selection. In this step the

researchers select the most relevant research articles Then they can be used to solve the research problems. This process involves five phases. Those are filtered by document type, Removing duplications, initial screening, the second round of screening and final screening. The selected research papers were based on getting a clear idea of the various Artificial Intelligence classes used in the Fashion and Apparel industry in order to check the types of revenues that can be used to address the above-mentioned research problems. The final step is information extraction which includes collecting articles and then classifying them into the sub-areas such as AI classes, Business to Business, Business to Customer approaches to address research questions, supply chain etc.

So, after the study was done using collected research articles, four main types of information can be extracted. Those are applied AI and algorithm, Business perspective: B2B & B2C, supply chain stage and research gaps. Table 2 below explains the classification of articles used in this review based on the research question.

Table 2. classification of articles used in this review

Article Classification		
Research Problem 1	**Research Problem 2**	**Research Problem 3**
Artificial Intelligence Classes	**Fashion and Apparel Supply chain stages**	
Machine Learning	Design	Business to Business (B2B0
Decision support Systems	Fabric Production	Business to Customer (B2C)
Expert System	Apparel Production	
Optimization	Distribution	
Image Recognition and vision		

According to above Table 2, research question 1 is focused on the overall trend of AI in the fashion and Apparel industry. Therefore, to address that question the techniques of AI has divided into 5 categories. These are Machine Learning, Decision Support System, Expert System, Optimization, and Image recognition & vision. These sub-sections will be discussed later in this review.

Research question 2 is focusing on identifying the various phases of the supply chain where the AI approach was used. As a result, the supply chain stage under consideration was recorded during the information

extraction stage. The supply chain was divided into stages such as Design, Fabric Production, Apparel Production and Distribution to address this question.

Research question 3 seeks to comprehend the scope of business problems that are the focus of research studies. To do this, the identified supply chain phases were further classified as B2B and B2C from a business standpoint. This classification of research articles was confirmed with the assistance of an experienced researcher who has been actively involved in research, linked to Artificial Intelligence and the financial services industry for the past two decades. Table 1 also mentions the expert researcher's competency.

Table 3. B2B & B2C activities in fashion industry

B2B	B2C
Fashion Design	Fashion Design
Textile Design	Textile Design
Spinning	Dyeing and printing
Weaving and Knitting	Cutting
Dyeing, Printing, Finishing and Inspection	Sewing and Assembly
Cutting	Finished garment
Sewing and assembling	Retailing
Wholesaling	E-Commerce
Retailing	

A. Classification of Fashion and Apparel supply chain stages

Fashion and Apparel is a very large industry that is involving various people across the world. This industry is associated with a variety of raw materials such as dyestuff, fabric, fibre, yarn, and other chemicals. The process related to this is classified into four stages namely, design, fabric production, Apparel production and distribution. The normal practice of the supply chain is to follow a push system. [6] The brand owners or clients supply information to manufacturers such as the design or technical specifications of the fabric/ garment to be manufactured, the volume of products to be produced, and the sizes in which the garment is to be produced. The garment and fabric sector carries out work according to the need of their client and follows the instructions they provide. The raw materials used for the apparel production are the finished fabrics which are being approved by the buyer/client. The final garments are then delivered to a wholesaler or store. There is another party which acts between the client and the wholesaler named the retailer. The retailers use various

channels to sell the garments such as e-commerce sites, department stores, etc. Also, the designers produce their creations based on the current market and analysis of the trends. It is considered that the brand owners have considered under the Business to Business(B2B) category since their primary customer is mostly another company or business. Also, most of the retailers do not own any marketplace or shop. So, retailers are considered under Business to Consumer(B2C) since consumers are their primary customers, unlike B2B. But with the increase the e-commerce sites and mostly e-markets the concepts of B2B and B2Cs are evolved. It is also critical to distinguish between B2B and B2C and how AI might assist in tackling challenges in both segments.

B. Classification of AI applications in the Fashion and Apparel industry

Artificial Intelligence is a well-known technology that can be used to address any kind of real-world problem. In the past few decades, the Fashion and Apparel industry had a huge evolution, especially with the usage of AI technologies. Various advanced machines are used in this industry to ensure the efficiency and quality of the products.[7] At the managerial level, the application of Artificial Intelligence is well explained and classified by operating processes in the Fashion and Apparel industry.[8] But when studying these research papers, the categorization is less. The issues in the operating process of the Apparel industry are explained by the research.[8] The mentioned study has revealed that Artificial Intelligence-related research is contributing to this industry's manufacturing issues by a percentage of 45%. Among them, 9% is about Apparel forecasting and 4.2% is about the recommendation of fashion.

3. Methodology

According to the research [17], which is a comprehensive assessment of classification and clustering techniques used in the F&A market, classification algorithms have been used more than clustering algorithms. On the other side, this study is not focusing on the linear and nonlinear predictive models. Also, it does not include areas such as customer analytics [9], optimization techniques [10], big data analytics, deep learning [11] and customization.

A. AI Technologies

AI is categorized into five broad areas by this research work which is mentioned above in Table 2.

1) Machine Learning: Machine Learning can train computers to perform an assigned task without the involvement of human beings. It uses the data patterns to learn by itself. Future decisions can be made using hidden patterns. These hidden patterns are predicted and found using mathematical models which are built on historical data.[12] Machine learning can be divided into two main

categories named Supervised Learning and Unsupervised Learning.

- Supervised Learning: It's a parametric model with input (independent variables) and output (dependent variable) [36]. Supervised model performance can be increased by iteratively improving model parameters [37]. Depending on the research objective, it could be a classification or regression task, with the dependent variable being categorical or numerical.

- Unsupervised Learning: Unsupervised learning models are made up of solely input attributes and independent variables, and their main goal is to group comparable data points. The process of grouping similar kinds of data patterns is called clustering. This process is used to create their labels.[12] The tasks such as sales prediction, demand forecasting, trend analysis, colour prediction and predicting fabric behaviour using mechanical properties are implemented using machine learning techniques in the fashion and Apparel industry.

The most used technologies under Machine learning were Support Vector Machine (SVM) and Predictive algorithms such as regression. Support vectors are data points that are closer to the hyperplane and have an impact on the hyperplane's position and orientation. By utilizing these support vectors, we increase the classifier's margin. The hyperplane's location will vary if the support vectors are deleted. These are the ideas that aid in the development of our SVM. Predictive analytics is used to make predictions about the future based on data from the past. The predictive algorithm can be applied in a variety of ways to assist businesses in gaining a competitive edge or developing better products, Predictive analytics algorithms either use "boosting" (a technique that modifies the weight of an observation based on the last classification) or "bagging" to try to obtain the lowest error feasible (which creates subsets of data from training samples, chosen randomly with replacement). Bagging is used in Random Forest.

2) Decision Support Systems: This technology is used at the commercial level of the organization to get high-level and mid-level decisions. It can be automated, regulated by a human, or a combination of the two. In some studies, the authors have mentioned these decision support systems as software tools while some other mentions that those can be integrated with the business to make intelligent decisions.[3] The mathematical model is combined with the conventional data retrieval methods in Decision Support Systems.[15] It is commonly utilized in the F&A industry to industrialize numerous jobs by streamlining decision-making processes in the supply chain.[16] This DS is very useful for the various stakeholders in this industry to select the most

suitable resources and processes while decreasing the overall costs and at the same time enhancing the performance of the Apparel supply chain.[17]

3) Expert Systems: Expert systems in AI have been used to make decisions without any involvement of human beings. To solve a very complex problem it usually uses a reasoning approach. It is categorized by the "if-then" rules. These expert systems can be classified again as inference engines and knowledge bases. The 'knowledge base' operates based on facts and rules, whereas the 'inference engine' applies the rules to learn the facts and generate new facts. For apparel manufacturing and production and also to select the appropriate equipment and processes these expert systems can be used. The usage of expert systems can help to reduce environmental pollution.[18] Also, expert systems are very useful to the fashion and apparel industry to improve customer satisfaction by the creation of recommendation engines and fashion retailing activities.[19]

Expert System technologies are Genetic Algorithms, Artificial Neural Networks, and fuzzy logic for the modelling purpose of the Fashion industry supply chain problems. An Artificial Intelligence and computing technique known as a genetic algorithm is a heuristic search technique. The theory of natural selection and evolutionary biology is utilized to identify optimum answers to search difficulties. Also, in order for the computer to learn things and make decisions in a way that is similar to that of a human, artificial neural networks are attempts to replicate the network of neurons that make up the human brain. Instead of the traditional "true or false" (1 or 0) Boolean logic on which the modern computer is built, fuzzy logic bases computation on "degrees of truth."

4) Optimization: The Artificial Intelligence can solve complex problems and provide them with numerous smart solutions through the process of intelligent searching. The traditional search algorithm begins with a random estimate and improves iteratively. Some of the methods of optimization are 'Random optimization', 'Hill climbing' and 'Beam search'. Another type of optimization search is an evolutionary algorithm. Some of the most famous genetic algorithms are gene expression programming, genetic algorithms, and genetic programming. GA is widely utilized in the F&A industry to solve scheduling and design layout issues in Fashion and Apparel industry.[20], [21] To improve the fitting services this algorithm has been used.[22]

5) Image Recognition and vision: Computer vision in AI is a scientific area which trains the machine to achieve high-level interpretation of images or videos. These images or videos can be received from any field such as global sensing position, cameras, and medical field. Extraction, pre-processing and creating supervised or unsupervised models and high-dimensional data are the tasks of computer vision

algorithms. These models are using different concepts such as statistics, geometry, and physics to get understanding about the images. This image recognition and vision technology is used by the fashion and Apparel industry to make the industrial applications automated such as inspection and process control.[22] This technique is also popular for virtual Tryon, content-based image retrieval systems and AR (Augmented Reality) in the Fashion and Apparel industry.[23], [24]

B. Artificial Intelligence for fashion in the Bigdata era

Artificial Intelligent can be used to create various methods which will be beneficial for the industry of fashion designing. AI can be used to handle the 3Vs of bigdata which is volume, variety, and velocity.[25] Hence it can handle the variations, uncertainties, and complexities of the market. AI techniques are already used by some of the leading companies, but it has not yet been spread properly among the middle level companies. Implementing these strategies is difficult because to the range of currently available methodologies, models, applications, and data formats. It is sometimes a huge challenge to the fashion companies. Consumer movements, such as the sustainable fashion movement, cause fashion customers' purchasing decisions to be increasingly motivated by a sense of consciousness rather than greed. Nonetheless, it can be argued that people have never consumed as many clothes as they do today, and as a result, the way they do it, has changed.

1) Data mining and fashion sales predicting methods:

Information is considered as one of the most important elements in the todays world which can be useful for so many industrial purposes as well as for the security. The big data environment is always attached to the economy, business life and also our daily life. In the context of Fashion, many sorts of data can be analysed: point-of-sale (POS) data, geographic information systems (GIS) data, social media data, virtual 3D data, sensory data, and textile physical data. Advanced approaches are required to manage the profitable usage of these data. Data mining is also another useful subfield of the Computer Science and Statistics sector, which involves discovering patterns in a large set of data at the confluence of machine learning, statistics, and database management systems. The objective is to extract information using intelligent methods from data sets and then convert them into a comprehensive form for further usage. A target data set must be assembled before data mining algorithms can be employed. For the fashion brand to survive in the industry it is crucial to collect the information and data efficiently. It is difficult to predict the success of fashion brands accurately since it has a very dynamic range of changes every day and the consumer trends might change regularly. It has proved that several AI methods can forecast the performance of fashion sales and

products.[25], [26] Today's fashion industry personnel and trend forecasters rely on the Internet to get information; they spend a large amount of time tracking what is being looked at online and who is looking. New technologies are assisting merchants in inventory management by utilizing AI-powered tools to monitor demand.

2) Virtual Style Assistants and fitting applications:

Forecasting is just one example that shows how AI can be applied in this industry. The fashion industry is almost transformed by AI technologies in the sectors such as designing, manufacturing, marketing, logistics and also sales. According to a WWD magazine article, the world's leading fashion sector sees AI allowing designers, companies, and retailers to develop better products and more appealing shopping experiences.[27] AI has made the shopping experience for consumers easier and more convenient. As an example, the Apparel retailer Gap introduced a "virtual Dressing Room" app in 2018 to assist customers in virtually trying on preferred goods. (Figure 1) [28]

Figure 1. GAP's Virtual Dressing Room shows the outfit on one of five different body types

mechanism is to scan and collect data on a person's foot from thirteen points and then measure the full shape of the foot. This process happens within a few seconds. Then fitting each Nike shoe style using the technology. For this process technologies such as data science, computer vision, machine learning, Artificial Intelligence and recommendation algorithms are being used. (Figure 2) [29]

Figure 2. Scanning application: Nike Fit foot

3) Artificial Intelligence as a fashion Designer:

Fashion experts have a small doubt whether the fashion design done by the creativity of the human being can complete using the computer. Fashion, as a materialization of the human dream concerning the human body, shape of the outfit's silhouette and production of custom beauty, is always an art, an activity aimed at designers and artists. Artificial Intelligence is considered augmented intelligence. Hence that can assist the human thought process in focusing on higher-value decision-making. So, it is proven that AI can become a fashion designer as well. The giant e-commerce

website, Amazon's research facility in San Francisco was opened in 2004. Lab126 has created an algorithm that can recognize specific fashion styles by tracing them on photographs; the technology can then make comparable styles of new goods. A straightforward but competitive AI fashion designer. (Figure 3)

Figure 3. Amazon's fashion algorithm that can develop Apparel by studying a large number of photographs, copying the style, and then applying it to new things

Nowadays AI-enabled features are used by fashion companies in society. They use social media such as Instagram and Pinterest to track the latest fashion trends and interests. The leading companies are powered with smart technologies such as ensuring higher speed while reducing the cost and improving flexibility at every stage of the supply chain. Also, it has got numerous capabilities in the areas such as forecasting and analysing the new fashion trends. Choosing and creating appropriate and sustainable fabric and colour combinations, designing the required cut with minimal waste, and organizing the production process most flexibly and sustainably are all examples of this.

5.   Results
A. The overall distribution of articles over time
Figure 4 depicts the total trend of publications published over three decades (1989–2018). Even though AI technologies were invented in the 1950s the usage of it was realized later in the last decade.
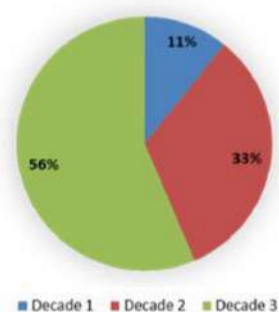

Figure 4. Total trend of publications

For journal papers, research has focused on three AI classes such as optimization, machine learning, and expert systems, although the expert systems are not employed in conference publications. Machine learning, decision support systems, and expert systems are the most utilized AI classes in

journal publications, whereas machine learning and image recognition have received the most attention in conference articles. All AI classes have been widely applied in fabric production, with a particular emphasis on machine learning and expert systems. In addition, image recognition is increasingly being used in fabric inspection, a procedure that falls under fabric manufacture.

6.   Discussion &Implications
Based on the review carried out following the established study framework and in response to the three research questions, this study identified several deficiencies in the application of Artificial Intelligence in the Fashion and Apparel industry which being discussed below. These deficiencies will direct future researchers on a novel path.

Even though AI technologies and methods existed since 1989, they have been popular among researchers only in the last decade how AI can be used to utilize the Fashion and Apparel industrial problems. Although AI technologies have been analysed by the researchers it is still not in a state to develop industrial-level productions by middle-level companies. The reason for this may be the researchers working in the AI industry might not have good expertise in the fashion industry as well as the industry professionals might not be expertise in Artificial Intelligence technologies. Also, the companies in the industries have less knowledge of how AI and big data can be useful for the betterment of their sector. As a result, they must consider the cost-benefit trade-off to fully realize the potential of AI. This study reveals that most of the researchers have carried out their work focusing on problems related to B2B business whereas a smaller number of research works have been carried out for the B2C business problems. The two major challenges faced by the fashion and Apparel industry are changes in consumer preferences and competition from online and other channels.

The study conducted shows that the widely used AI technologies are machine learning and expert systems. They have been widely used in the areas of the supply chain, fabric production, and distribution. A similar number of research publications have been published on this subject in the decision support systems, optimization, and image recognition classes. The least number of algorithms was observed in the design stage. It implies that less focus has been put into the design-related problems. So, the scope for Artificial Intelligence applications is high at this stage. As an example, Artificial Intelligence can be used to develop systems which are capable of getting the consumer's needs more accurately and efficiently. So, this industry can aim for various market segments. Also, it is possible to analyse the consumer's lifestyle patterns and preferences such as the user's history and social media usage to develop the best suiting products for them.

7. Conclusion

The main objective of this study was to conduct a systematic review of three main problems identified in the Fashion and Apparel industry with the usage of AI. According to the research area around, 25 to 30 research articles were able to be found in the two popular databases known as Scopus and Web Science. The article screening procedure was divided into five stages. To extract information from these publications and achieve the study objectives, a classification was established that considers AI methodologies and F&A supply chain stages while admitting RQ1 and RQ2. When considering the RQ3 supply chain of the fashion and Apparel industry was classified as B2B and B2C. According to the analysis it is discovered that most of the activities related to the Fashion and Apparel industry using AI technologies happened in the last decade which is from 2009 to 2018. The most applied AI technologies are Machine learning and Expert Systems. The most used technologies under Machine learning were Support Vector Machine (SVM) and Predictive algorithms such as regression. Also, it has been found that the most widely used Expert System technologies are Generic Algorithms, Artificial Neural Networks, and fuzzy logic for the modelling purpose of the Fashion industry supply chain problems. The other AI technologies such as transfer learning and deep learning were not much used. This industry has not discovered the actual benefits of using technologies like big data and other AI technologies to expand their industry. This has been well proven through the research done by various researchers. During the study, it was found that more attention to the usage of AI was applied to the supply chain stages such as Apparel production, Fabric production and distribution whereas less attention towards the designing process. A considerable amount of focus was held on the Business when compared to Business to Consumer. As a result, to provide consumer-oriented solutions to the industry, research must adopt a B2C perspective. This allows the industrial supply chain to transition into a more digitalized and sustainable state. The conclusions and future directions provided in this study will be useful for academic and industrial researchers, as well as industrial practitioners, who wish to make a significant contribution to the field. Despite its importance, this study does have significant drawbacks. Firstly, even though the research articles were extracted only from two databases, there could be various other databases to find articles. Secondly, the other issue is the language barrier, articles from other languages related to the same research field was excluded.

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