



# 15<sup>TH</sup> INTERNATIONAL RESEARCH CONFERENCE

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

29<sup>TH</sup> - 30<sup>TH</sup> SEPTEMBER 2022

TECHNOLOGY

**ABSTRACTS**



GENERAL SIR JOHN KOTELAWALA DEFENCE UNIVERSITY



# **15<sup>TH</sup> INTERNATIONAL RESEARCH CONFERENCE**

**ECONOMIC REVIVAL, NATIONAL SECURITY, AND SUSTAINABILITY  
THROUGH ADVANCEMENT OF SCIENCE, TECHNOLOGY, AND INNOVATION**

**TECHNOLOGY**

# **ABSTRACTS**



**General Sir John Kotelawala Defence University**

**Ratmalana, Sri Lanka**

This book contains the abstracts of papers presented at the Technology Session of the 15<sup>th</sup> International Research Conference of General Sir John Kotelawala Defence University, Ratmalana, Sri Lanka held on the 29<sup>th</sup> and 30<sup>th</sup> of September 2022. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form, without prior permission of General Sir John Kotelawala Defence University, Ratmalana, Sri Lanka.

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## Message from the Secretary, Ministry of Defence



I am indeed delighted to pen this message whilst extending my earnest felicitations to the KDU on this significant occasion of the annual International Research Conference. At this juncture, I would also like to congratulate the Vice-Chancellor and the team for continuing the tradition of organising this conference consecutively for the 15<sup>th</sup> time, despite the numerous economic and social challenges faced by the country in the post-COVID environment.

Further to that, I am delighted to perceive that this year's conference theme; 'Economic Revival, National Security, and Sustainability through Advancement of Science, Technology, and Innovation' focuses on the National Economic Growth and National Security as core concepts, and suggests that 'economic development' and 'security' of a country should always go hand in hand. Therefore, this conference would undoubtedly become a forum for academia to discuss an area of absolute need in the development interests of our motherland.

Moreover, I am pleased to witness that KDU, under our ministerial guidance, is setting an example for all other universities in Sri Lanka in progressing research in many academic fields. I hope this year's conference will produce a significant research outcome that the policy community of Sri Lanka could utilise to support the present development drive of the country. Further, I would like to urge the conference organisers to explore the possibility of distributing the outcomes of the conference to all the relevant Ministries and Departments of the country so that said entities could link with the researchers and employ their valuable research outcomes for the benefit of the nation.

I wish that KDU IRC 2022 will enhance the wisdom of all the participants to serve Mother Lanka for a better tomorrow.

**GENERAL KAMAL GUNARATNE (Retd)**

WWV RWP RSP USP ndc psc MPhil  
Secretary - Ministry of Defence

## Message from the Keynote Speaker



It gives me immense pleasure to send this message on the occasion of the 15th International Research Conference of the General Sir John Kotelawala Defence University (KDU). I would like to congratulate KDU for being able to conduct its International Research Conference in 2022, consecutively for the 15th time. It is not an easy task to organize such a momentous event particularly under many difficulties and challenges posed by the COVID 19 pandemic situation and social and economic crisis. It is gratifying to witness that KDU, the only Defence University in the country, has been able to transform a challenge into an opportunity, as it usually does.

The theme of the conference, namely the “Economic Revival, National Security, and Sustainability through Advancement of Science, Technology, and Innovation,” is very timely and of great significance for deliberation in expert panels of this conference. The nexus between National Growth and National Security is closely interwoven. The ‘economic revival’, ‘sustainability’ advancement’ and ‘security’ of a country cannot be compartmentalized and discussed in isolation of each other. There is no security for a nation without economic and social progress, and likewise, economic and social progress cannot be achieved without stability and a secure environment. I hope various panels of this conference will be able to discuss many facets of economic revival, national growth, sustainability and security and their interconnectedness. These two areas have a direct bearing on the development of Sri Lanka, a country which succeeded in ending a 30-year long separatist war. In the context of the present need for robust development, it is absolutely necessary to engage in serious research which leads to discoveries as well as policy-oriented recommendations. Therefore, all academic establishments must provide a conducive space for their intellectuals to reach new frontiers in research. I am glad that KDU is setting an example for all other universities in Sri Lanka in this regard. I hope this year’s conference will produce significant research outcomes that the policy community in Sri Lanka could utilize for the benefit of the country. I wish this conference all the success.

**HON PROF SUBRAMANIAN SWAMY**

Former Minister of Commerce, Law & justice, India



## Message from the Vice Chancellor



The International Research Conference (IRC) of General Sir John Kotelawala Defence University held for the 15<sup>th</sup> consecutive year is significant in terms of the continued contribution of the University to the field of research in diverse disciplines much needed for the progression of the nation, especially in the face of unprecedented challenges caused by the COVID-19 pandemic and the current economic crisis in the country.

The conference themes carefully selected by KDU each year have addressed contemporary needs of the country that are linked up with national security perspectives, and they are complementary to the development paradigm of the country. This year's theme "Economic Revival, National Security, and Sustainability through Advancement of Science, Technology, and Innovation" encompasses a wide range of research possibilities for scholars of different disciplines to engage in much useful research relevant to the current issues faced by the nation.

It is heartening to note that the number of papers submitted for the conference has increased despite the challenging circumstances, which is a positive indication of the enthusiasm growing in the country on development and security related multi-disciplinary research. In this respect, I am extremely glad that the KDU's efforts in expanding higher educational opportunities, increasing quality of higher education, enhancing research and innovation, linking up research with the industry and so on have increasingly been acknowledged by many, which is also reflected in the Times Higher Education Impact Ranking, 2022 table, where KDU has been ranked 2<sup>nd</sup> in Sri Lanka for Quality of Education and 4<sup>th</sup> in the overall ranking in the country and in the 801-1000 range globally.

KDU IRC also creates a sound platform to initiate collaborative research at both national and global levels, and I invite all participants to use this conference to make lasting and productive connections and networks at the individual, institutional, national, and international levels to envisage and explore mutually beneficial research possibilities and higher education experiences for the future.

While appreciating the commitment of the organizers of this year's conference, I wish you all, the presenters and participants taking part in the conference all the very best, and I hope you will enjoy every moment of this two-day academic endeavour.

**MAJOR GENERAL MILINDA PEIRIS**

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

## Message from the Conference Chair



For the 15<sup>th</sup> consecutive year, General Sir John Kotelawala Defence University (KDU), organises its International Research Conference (KDU IRC 2022) under the theme of “Economic Revival, National Security, and Sustainability through Advancement of Science, Technology, and Innovation”. It is with great pleasure and honour that the organising committee extends its compliments to all of you taking part in KDU IRC 2022. Holding the KDU IRC 2022, under the patronage of the Vice Chancellor, amidst many challenges encountered throughout the year, was a remarkable experience for me. I believe that the organising committee accomplished a very successful mission.

Despite the economic crisis, KDU IRC 2022 is a tremendous opening for many researchers all over the world encompassing various disciplines such as Defence and Strategic Studies; Medicine; Engineering; Management, Social Sciences and Humanities; Law; Built Environment and Spatial Sciences; Allied Health Sciences; Basic and Applied Sciences; Computing; Criminal Justice and Technology to present their research to fellow scholars, professionals, and students.

In this context, we have assembled excellent thought-provoking scientific sessions under the conference theme of this year, and it is remarkable to highlight your participation, at this conference through a highly competitive selection process. In addition, world-renowned invited speakers will deliver keynote and plenary speeches while covering a wide range of important sessions with great networking opportunities and providing solutions using science, technology, and innovation. It is the esteem of the conference to bring together a diverse group of people to disseminate high-quality and novel research results, which will assist to chart our journey forward to reach new heights.

Finally, I would like to extend my best wishes to all the presenters, authors and participants, joining the KDU IRC 2022 on site or online, and I hope that all of you will find this conference informative, enjoyable, and encouraging to feel the experience of KDU hospitality during these two fruitful days.

**DR KALPA W SAMARAKOON**

PhD, MSc, BSc, MACS (USA), M.I.Biol (SL), C.Biol (SL)  
Conference Chair  
General Sir John Kotelawala Defence University

## Message from the Conference Secretary



Together with the committees and participating academia of this university, I share the immense pleasure and honour of perseverance with the 15<sup>th</sup> International Research Conference of KDU (KDU IRC 2022), amidst many challenges, under the patronage of our Vice Chancellor and Deputy Vice Chancellor.

The timely congregation for IRC 2022, of all our staff, students and contributors from faculties all over the world, under the theme “Economic Revival, National Security, and Sustainability through Advancement of Science, Technology, and Innovation”, is of paramount importance in this current climate of the global recession.

Whilst thanking all of you, I express my sincere hope that this would be an ideal platform for academia and professionals to discuss economically viable intelligent solutions for diverse problems for the nation to emerge stronger out of the recession, with the ability to provide equitable health, food, and social security, quality education, and enforcement of law and order in our country, for the betterment of our society.

### **DR PANDULA ATHAUDA-ARACHCHI**

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## **ORAL PRESENTATIONS**

# An Algorithm for Preventing Denial of Service Attacks on Server Computers Using a Low Bandwidth in a Local Area Network

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In the present cyber world, Denial of Service (DoS) attack is a major threat for server computers. When the bandwidth of servers gets low, the damage that can be made by DoS attacks is very high. Even though there are enormous solutions to prevent DoS attacks, since the cost is high, most organisations cannot afford them and other cheapest solutions have a high computational cost, which affects the performance of the servers. This paper introduces an algorithm to prevent DoS attacks on server computers (which use a low bandwidth) in a local area network (LAN) without affecting the overall performance of the server and its legal clients. The algorithm is implemented to take counts of the requests and identify the MAC address of those request sources. Afterwards, the algorithm checks whether the same request arrives from the same MAC address repeatedly. If the result of that is true, then the algorithm attempts to block the request from that MAC address. The developed algorithm was tested in a server which uses a cent OS 7 server operating system and proved the algorithm can prevent one DoS attack at a time. It is cost effective to use and does not affect server performance and its clients unlike other methods because it does not use any kind of high-cost data storing mechanisms. This paper describes the algorithm development in detail and proves its effectiveness using an experiment.

**Keywords:** *bandwidth, denial of service, local area network, MAC address, packets, request, server*

# Public Procurement Procedures and Project Implementation for the Digital Age: A Sri Lankan Perspective

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Procurement of Information Systems (IS) is a complex process since it could range from off-the-shelf standard products to highly customised systems. The dynamic nature and rapid development in the IS sector often make its procurement to be incompatible with traditional red-tapes and the procedural approach in public procurement methods. This study focuses on identifying the gaps between the two domains and the ways to overcome the challenges with the aim of making necessary recommendations to public IS procurement processes. The Modified Delphi method is adopted as the primary research technique. In the first Delphi round, interviews were conducted with a selected portion of an expert panel. Interview questions were formulated using problems identified through a Literature Survey. Expert opinions on the solutions to the listed problems and problems they encountered in their careers were then formulated into a close-ended questionnaire for the second Delphi round in which the full panel of experts generated a set of recommendations to overcome challenges identified in the first Delphi round. The recommendations are categorised under tender specifications, bid-evaluation criteria, government regulations, project management, collaboration among procurers and bidders, and competence of procurers. The recommendations were ranked according to their level of importance for presentation. The findings of this research can be adopted to improve the existing public procurement procedure and project implementation in the IS domain.

**Keywords:** *Public Procurement, Information Systems, Delphi method*

# Improving Visibility at Night with Cross Domain Image Translation for Advance Driver Assistance Systems

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The most difficult time for driving is at night because of the dreadful lighting conditions. It was identified that 50% of the traffic deaths happen at night, even though only one-quarter of our driving happens at night. Therefore, having clear visibility at night is crucial for a safe drive at night. Most Advanced Driver Assistance Systems (ADAS) also fail at night due to poor lighting. Considering this matter, this study will explore the possibility of translating night-time images to clear and detailed images with day-time lighting (i.e., equivalent daylight images). This can be identified as a cross-domain image translation problem between the day-time domain and the night-time domain. Even though many deep-learning-based techniques to transform images between domains exist, most of them require pixel-to-pixel paired datasets for training. However, it is challenging to develop such a dataset in this scenario, since roads are dynamic and uncontrolled environments. As a solution, this study utilised a well-known Cycle-GAN model, which can be trained using an unsupervised training approach. Therefore, this study explores the possibility of transforming images between day-time and night-time using Cycle-GAN. The other challenging task of this study is to access the quality of the Cycle-GAN generated images, since there is no pixel-to-pixel paired image to compare against. Therefore, this study utilizes a reference-less image quality evaluation technique called Blind Reference-less Image Spatial Quality Evaluator (BRISQUE). The day-time images synthesised by the trained Cycle-GAN indicated a 28.0416 average BRISQUE score, whereas the original day-time images indicated a 26.2156 BRISQUE score, which indicates that there is only a 0.069% deviation. Dataset and the source code used for this study are available at <https://github.com/isurushanaka/GANresearch/tree/main/Night2Day/Experiments/Unpaired>

**Keywords:** *night-driving, image translation, cycle-GAN, unsupervised learning, BRISQUE, ADAS*



## **A Review on Reimagining Medical Education with Virtual Reality in Emerging Medical Disciplines**

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Involvement of emerging technological improvements is essential in medical disciplines to provide adequate medical treatment. Virtual reality is one of the latest and most applicable technologies that can facilitate medical professionals and patients in several ways, while treating diseases. Furthermore, virtual reality enhances a medical student's knowledge and abilities in various ways. Therefore, it is fascinating to explore the potential of virtual reality for improving the medical education experience in an academic study. This research provides a review of virtual reality in medical education, and finds how medical students and professionals are aware of the applications of virtual reality in medical education and practices.

**Keywords:** *Virtual reality, Medical education, simulation, 3D environment, medical training, medical discipline*

## Determination of Heavy Metal Tolerance and Removal Ability of the *Staphylococcus sp. TWSL\_1* Isolated from an Industrial Effluent

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Heavy metal contamination has become a major threat to the environment as well as to mankind. Bacteria demonstrate a considerable resistance to heavy metals because of evolved metal resistance. Hence, it would be useful to identify metal resistant bacteria to be used in mitigating metal pollution. This study was carried out for the isolation, molecular characterization and determination of bioremediation capacity of a bacterial strain. Metal tolerant bacterial strains present in a textile industry effluent were screened on LB agar plates. Well isolated bacterial colonies were screened for heavy metal resistivity by observing their growth in media containing heavy metals. The bacterial strain *TWSL\_1*, which grew well ( $p < 0.0001$ ) in metal spiked media was selected for further analysis and its heavy metal tolerance was determined by observing the growth with time by measuring the optical density at 600 nm using a scanning UV-VIS spectrophotometer. Heavy metal removal ability was determined by measuring metal concentrations using AAS. Bioremoval ( $p < 0.05$ ) of *TWSL\_1* was  $65.85 \pm 1.85\%$ ,  $43.07 \pm 1.70\%$  and  $70.98 \pm 1.41\%$  for  $\text{Cu}^{2+}$ ,  $\text{Cd}^{2+}$  and  $\text{Pb}^{2+}$  respectively and the highest MIC was for  $\text{Pb}^{2+}$  (1200 mg/L). To molecularly characterize the isolate *TWSL\_1*, the 16S rRNA gene sequence of extracted genomic DNA was amplified using universal primers and the amplified product (~1500 bp) was sequenced and analysed. The sequence was found to be similar (97%) to 16srDNA sequence of *Staphylococcus warneri* strain *RED5B* (Accession No: MW144878.1) in the NCBI database. Whole genome sequencing was carried out using next generation sequencing followed by De Novo assembly. The isolate *TWSL\_1* was reconfirmed as *Staphylococcus warneri* and annotation data revealed the presence of several genes encoding proteins involved in heavy metal tolerance.

**Keywords:** *Staphylococcus sp. TWSL\_1*, heavy metals, bio-removal, Industrial effluent

## **Green Synthesis of Iron Nanoparticles from Long Coriander (*Eryngium foetidum*) Leaves Aqueous Extract**

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Green synthesis method is becoming more popular as an economical, energy-efficient, low cost and environment-friendly way of synthesis of iron nanoparticles (FeNPs). In this study, the aqueous extract of long coriander (*Eryngium foetidum*) leaves was used as reducing and stabilising agents in the synthesis of FeNPs. The aqueous extract of long coriander (*Eryngium foetidum*) leaves can reduce from Fe<sup>3+</sup> into iron nanoparticle (Fe<sup>0</sup>) at room temperature. The green synthesised iron nanoparticles were characterised by Scanning Electron Microscope (SEM) analysis, Energy Dispersive X-Ray (EDX) analysis, X-ray diffraction (XRD) analysis, Fourier transforms infrared (FTIR) spectroscopy analysis and UV-Visible (UV-Vis) spectroscopy analysis. The particles were identified as being on the nanoscale by SEM images and their surface morphology was revealed to be a spherical shape with a particle size range of 30-50 nm. The elemental composition of synthesised iron nanoparticles was detected by EDX spectroscopy analysis, which also revealed that the nanoparticles are primarily present in metal form. The XRD spectrum observed the crystal structure of the synthesised FeNPs, which are crystalline in nature with a size of around 43.30 nm. The FTIR spectrum exhibited different characteristic bands, which indicated the different functional groups of the active components in synthesised FeNPs. The UV-Visible observed the absorption peaks at the 250-295 nm region due to the excitation of surface plasmon vibrations of the FeNPs and the maximum peak was shown at 272 nm. The green synthesis method from synthesised FeNPs can be applied for a wide range of industrial applications.

**Keywords:** *green-synthesis, environment-friendly, iron nanoparticles, long coriander, room temperature*

## **Design of Hybrid Blade Profile for Stand-Alone Wind Turbine Generator Systems**

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Vertical Axis Wind Turbines (VAWT) play a key role in wind energy technologies, where wind energy is one of the most cost-effective sources of renewable green energy (Yokoi, 2005). VAWTs are not sensitive to the direction of the wind and do not require any special mechanism to point out the turbine towards wind direction like in Horizontal Axis Wind Turbines (HAWT). Different designs of VAWTs are being used in the world and VAWTs excluding the Savonius type are taken into consideration under this project scope, where its aerofoil blade profile is crucial for efficiency. Generally, the VAWTs are less efficient relative to HAWTs. Also, the VAWTs have a poor starting torque. Typical VAWTs utilise only the lift force acting on the blades to make the turbine rotate. However, a limited number of hybrid blade profiles are found to be invented for VAWTs, by which they can utilise both lift and drag forces for the rotation of the turbine. In this study, a hybrid blade profile for VAWTs is developed to make use of the combined effect of lift and drag forces with the ultimate goal of achieving a higher efficiency in harnessing wind energy and to overcome the problem of poor starting torque. CFD simulations were performed to evaluate performance of existing hybrid blade profiles, and the best design out of those profiles was further modified and evaluated to meet the objectives. Prototype of the modified blade profile was fabricated and tested with a comprehensive testing equipment developed and fabricated to evaluate the practical performance of the blade profiles.

**Keywords:** *Vertical Axis Wind Turbine (VAWT), hybrid blade profiles, Horizontal Axis Wind Turbine (HAWT), Computational Fluid Dynamics (CFD)*

# Use of Sensor-Based Automated Irrigation for the Mitigation of Groundwater Depletion and Pollution Issues in Kalpitiya, Sri Lanka

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Kalpitiya, is an important agro ecological region in Sri Lanka, which has greatly strengthened the country's economy and food security. However, intensive farming practices in Kalpitiya have triggered its ground water depletion and pollution issues. The objective of this study is to check the feasibility of a new sensor-based irrigation system against the prevailing groundwater depletion and pollution issues in Kalpitiya. The new system was used to automate a sprinkler kit by monitoring underground moisture contents via its high-frequency soil water content sensors placed at 15, 45 and 90 cm depths. During the study, irrigation uniformity and adequacy of the automated sprinkler kit (T1) were compared over those of the sprinklers operated with common farmers' experience based (T2) and timer controlled (T3) irrigations. T2 and T3 were also provided with the soil moisture detection facility as same as in T1. According to the results, the irrigation uniformities of T1, T2 and T3 were within an acceptable range (83-88%), but only T1 had 60% irrigation adequacy within 30cm depth. Further, soil water telemetric graphs and adequacy values also proved that deep percolation was considerably higher in T2 and T3 over T1. The study confirmed that new sensor-based irrigation control was capable in saving irrigation water and minimising groundwater leaching through its real-time soil moisture-sensing mechanism. Thus, the new technique had the potential to be used against ground water depletion and pollution issues in Kalpitiya.

**Keywords:** *groundwater, Internet of Things, Kalpitiya, sprinkler irrigation, soil water content*

## **The Influence of Aerodynamic Drag in the Flight Phase of Long Jump Performance**

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Three different air dynamics are employed when performing the long jump and each has a different impact on performance. In a variety of sporting events, aerodynamic forces have a considerable impact on strategy and performance records. This study is aimed at determining how much wind and air resistance contributed to long jump performance. Investigations were conducted on the relationship between the Drag force (D) and time for various flying techniques. Six male senior long jumpers' best performances at a national competition in Sri Lanka were considered for this study. Two of each technique's best performers were used to analyse (Kinovea 9.5 software) all three of the techniques. Two cameras were used to record the performances in the frontal and sagittal planes (100 Hz). The coordinates of each athlete's Centre of Gravity were examined for each frame from the take-off through the landing phase. Separately, the frontal plane and sagittal planes were used to complete the space calibration to get the frontal surface area of the body for each frame. The study calculated the aero drag force using the equations of Reynolds number and aerodynamic force. The drag force for each time frame for the three techniques fluctuated approximately between 7N to 11N. This leads to reduce the horizontal flight distance.

**Keywords:** *air resistance, body surface area, frontal plane, wind velocity*

# POSTER PRESENTATIONS

## Identifying an Air-Conditioned Room's Comfortable Zone with Respect to the Room Dimensions and Position of A/C Unit Mounted

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The goal of the study project is to assess the thermal comfort in the Mechanical Lecture Room (MLR) at Faculty of Engineering, University of Ruhuna in order to find the comfortable zone in that air-conditioned room. The subject room with dimensions of 14.66m x 5.10m x 5.13m and set up with two 36000Btu/h Split Type air conditioners were tested. The room air temperature varied from 18.5 Celsius to 24.6 Celsius, when both A/C machines were operating at 17 Celsius. The length of the MLR was divided into 12 parts, while the width was divided into 6 equal parts. The Temperature values were taken by using 10 J-type thermos couples. The findings of this study can be used to build and control air-conditioning systems for the identification of a room's comfort zone in relation to the size of the space and where the air conditioner is positioned.

**Keywords:** *thermal comfort, air-conditioned room, relative humidity, temperature, air flow variation*



## Secure Data Transformation in Cloud Using Hybrid Cryptography

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The Cloud is a very well-known and accepted data storage that provides many benefits to users with a pay-as-you-go pricing model, even providing storage solutions for massive amounts of data. Many users nowadays use different Cloud services, mainly because the data can be accessed from anywhere via the internet. Cloud servers are located all over the world, storing massive amounts of data. When a user uploads or downloads from the Cloud server, the data is exposed to the internet. This can lead to security issues, such as unauthorised disclosure of data and lack of user privacy if the data is not properly protected. Many cryptographic algorithms are used to secure data transformation in the Cloud. The proposed system is designed to offer a method for properly securing data when transferring them to the Cloud, utilising various cryptographic techniques, and integrating them most innovatively and effectively considering the security, data integrity, speed and data confidentiality. The data is encrypted using a combination of three algorithms namely AES, ECC and RSA by increasing the security of the data. The keys generated by the ECC and RSA are combined using an Exclusive OR gate. The AES key is uploaded into the key management server after being encrypted by the newly generated key. The data encrypted by the AES key are uploaded into the Cloud storage. The proposed system is intended to distinguish the features and functionalities to overcome the drawbacks of the current systems.

**Keywords:** *RSA, Elliptic Curve Cryptography (ECC), AES, cloud, key management server*

## **Evaluation of Growth, Yield and Nitrogen Losses from Leafy Red Onion Cultivation with Different Fertilizer Practices in Kalpitiya Peninsula**

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Intensive agriculture practices together with increased fertilizer use have a greater impact on groundwater quality in Kalpitiya. Water demand in Kalpitiya is 70%, fulfilled by groundwater extractions. The permeable nature of sandy Regosols causes leaching of nutrients and contamination of shallow groundwater. The aim of this study was to evaluate the effects of different fertilizer practices on growth, yield and nutrient leaching in leafy red onion grown in Kalpitiya. The red onion is the major crop grown in large scale. The treatments tested were T1-Farmer Used Rate of fertilizer and T2-Department of Agriculture recommendation. The experiment was arranged in Completely Randomised Block Design with three replicates in six plots (7.2m<sup>2</sup>). The red variety of Jaffna Local was established in a research field where lysimeters were previously installed. The leachate was collected weekly from lysimeters and analysed for leached nitrogen. Growth of plants and yield were recorded. A significant difference in leached nitrogen was observed between treatments. Furthermore, it was observed that there was a statistically significant difference between the final yield of T1 and T2 treatments. The total nitrogen leaching percentage of T2(67.88%) was lower than T1(78.86%), even though the crop yield of T2 (5069.25kg/ac) was lower than T1(7556.95kg/ac). The average concentration of nitrate in the leachate of T1 was 73mg/l, while that of T2 was 72mg/l. The safe limit of nitrate in groundwater is 50mg/l. Recommended amounts of fertilizer should be applied in balanced proportion and at appropriate times with soil amendments, which may help to absorb nutrients efficiently. Therefore, the study concludes that both practices showed leached nitrate concentrations above safe limits recommended by WHO, which urges the need for change in nitrogen fertilizer management for red onion on sandy regosols.

**Keywords:** *nitrification, groundwater contamination, sandy regosol*

## A Modified Green Building Rating System to Evaluate Sustainability Aspects in Residential Apartments in Sri Lanka

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Residential apartments have been identified as the most popular solution for the rapid increase of population in urban cities. However, in some cases, sustainability aspects (environmental, social and economic) of these apartments are abandoned. Further, there is no unique system to evaluate the sustainability of these apartments in Sri Lanka, and most international green building rating systems have unequal point distribution among sustainability subsets, which causes heterogeneity among subsets. Thus, this research was designed to develop a modified sustainable rating system for residential apartments in Sri Lanka, thereby reducing the sustainable subset heterogeneity by introducing modified point distribution percentages (Environment [40%], Social and Economic [30%]). The apartments certified under the GREENSL rating system for the built environment were selected as three case studies. The claimed points for GREENSL certification by GREENSL Platinum, Gold and Silver-rated apartments were evaluated under the three sustainability subsets. The results revealed that three subsets were not equally considered in the GREENSL rating system (Platinum-rated: Environment [50%], Social [21.6%], Economic [28.4%]; Gold-rated: Environment [50%] Social [29.5%] Economic [20.5%]; Silver-rated: Environment [47.6%] Social [27.8%] Economic [24.6%]). Further, the sustainability status is satisfactory in the social dimension, irrespective of the level of certification. Based on the findings, a modified rating system was developed for residential apartments by adopting new sustainability criteria including compartmentalisation, interior moisture management, air purification, enhancing acoustic performance and disaster risk reduction. The study revealed that sustainability practices of residential apartments in Sri Lanka need further improvement, while providing more weight on social and economic pillars.

**Keywords:** *GREENSL for built environment, residential apartments, sustainability subsets, sustainable subset heterogeneity*

