KDU IRC
INTERNATIONAL RESEARCH CONFERENCE

15TH INTERNATIONAL RESEARCH CONFERENCE

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

29TH - 30TH SEPTEMBER 2022

BUILT ENVIRONMENT AND SPATIAL SCIENCES

ABSTRACTS

GENERAL SIR JOHN KOTELAWALA DEFENCE UNIVERSITY

15TH INTERNATIONAL RESEARCH CONFERENCE

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

BUILT ENVIRONMENT AND SPATIAL SCIENCES

ABSTRACTS

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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 15th 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 15th 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 2nd in Sri Lanka for Quality of Education and 4th 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 15th 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 15th 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

Review on the Height Datum Unification in Sri Lanka

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Single or multiple Tide Gauges (TGs) observations are typically used to observe the sea level changes and those observations are used to define either the vertical datums/Local Vertical Datums (LVDs) island-wide or continental-wide. The national geodetic datum is the most significant framework for any surveying work in a country in areas like construction, engineering, mapping, or hydrography. This network usually consists of both horizontal (latitude and longitude) and vertical (height) components with a higher order of accuracy to fulfil the survey and mapping needs within the country. Vertical datums are based on the geopotential whereas horizontal datums are geometric. Vertical datums are mostly based on the equipotential surface like the geoid, an equipotential surface that coincides with the Mean Sea Level (MSL) of the oceans. Currently, there are numbers of LVDs existing in the world and usually, they are used to define using spirit levelling, gravimetric observations, and TGs observations, and it was continuously described within the geodetic literature over the past decades. Sometimes within that, it can be identified Global Vertical Datums (GVDs) which were based on the low-resolution geoids. According to the International Association of Geodesy (IAG), one of its main tasks is to create unification of the existing LVDs around the world through the Global Geodetic Observing System (GGOS). The main objective of this study is to identify a suitable vertical datum unification method that can be applied for the vertical datum in Sri Lanka which was formed in the early 1930s and it is essential to re-observe it in order to fix the potential datum bias due to various geodynamic effects. The concept of the Unification of height/vertical datum is increasingly interesting nowadays, and it makes the comparison of various datums in different regions possible. Our study revealed that the Geodetic Boundary Value Problem (GBVP) approach is the most appropriate process that can be used for the unification process of the vertical datum in Sri Lanka.

Keywords: *geodetic boundary value problem, mean sea level, unification, vertical datum, tide gauge*

Analyzing the Effects of Land Use and Land Cover Changes on Paddy Cultivation Using Remote Sensing: A Case Study of Sooriyawewa, Sri Lanka

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Land-Use and Land-Cover (LULC) change research is a type of environmental research that is closely associated with socioeconomic development. At present, the LULC changes mainly occur due to physical developments and agricultural processes. Paddy is one of the major crops grown in Sri Lanka. Hambantota district is ranked in the fifth place in rice production in Sri Lanka, and Sooriyawewa is the driest Divisional Secretary Division (DSD) in Hambantota District, but it is recorded as the DSD with the most paddy cultivation. However, nowadays there are a number of factors that hinder the paddy cultivation there. This research aims to identify the existing system for monitoring the LULC changes in paddy cultivation, to recommend applicable Remote Sensing techniques, to quantify the LULC changes over paddy cultivation in Sooriyawewa during the past 4 decades and finally to examine the underlying causes for LULC changes over the paddy. For this research, Landsat images were downloaded from 1980 to 2019 with a specified time gap and supervised classification was used for the land cover classification for all images to detect the paddy variation in this area. The obtained net changes between 1980 to 2019 are: paddy, other crops, forests, water bodies, built up areas and barren lands. According to the LULC changes between 1980 to 2019, there was a -15.50% decrease in paddy areas but built-up areas, other crops indicate significant increases of 11.97% and 10.08% respectively. This is a temporal problem in this area and this study is useful for relevant authorities for decision making, preparing urban development plans, planing infrastructural development and supervision, land use planning, natural resource conservation and environmental sustainability.

Keywords: *land use and land cover, classification, remote sensing*

Impact of Flood on the Built-up Environment:
A Case Study of Baddegama DS Division

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Floods, a recurring phenomenon primarily in low-lying basin areas can be interpreted as beneficial for improving soil structure and cropland products, but they can also be viewed as one of the most catastrophic natural disasters adversely affecting human life and the environment. The main reason for flooding in Baddegama area, is the Ging River flowing through it. The purpose of this research is to help prevent the damage caused due to the lack of proper understanding of the flood risk in built-up areas. To identify the riskiness of the built-up area, it should overlay the flood inundation map and built-up area map. To create a flood map, five criteria were selected according to the ideas of well-knowledgeable people who lived in the Baddegama area. Land Use and Land Cover (LULC), slope, rainfall, soil, and water features were identified as the criteria that were affected by the flood in the area. An analytical hierarchy process was used to scale the criteria, and the weighted overlay method was used to create the flood map. LULC map as well as a built-up map were created using a Landsat 8 image and a method of supervised classification. The built-up area map was created after performing the Normalised Difference Built-up Index (NDBI). Most built-up areas in the Baddegama are under moderate flood risk. Further, 14% of built-up areas are at high risk. As a final output of this study, the riskiness levels of the built-up area could be used when establishing evacuation centres.

Keywords: *Normalised Difference Built-Up Index (NDBI), supervised classification, weighted overlay*

The Use of Unmanned Aerial Vehicles for Façade Surveying Application in Sri Lanka

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Unmanned Aerial Vehicle-systems (UAVs) or Drones have reserved an important place in the construction and engineering industries over the last few decades. Drones are employed in various parts of the construction and engineering industries, including project creation, project management, and inspection, construction surveying, construction safety, construction inspection, volume measures, modeling in 3D, and other related services. UAV technical advancements and structure from motion methodologies have resulted in UAVs being typical platforms for 3D data collecting. Drones appear to be an ideal choice for urban applications due to their flexibility and capacity to reach inaccessible urban areas. Reconstructions from drone data have the potential to drastically reduce labor costs for rapid upgrades of already reconstructed 3D cities. However, a rigorous quality assessment is required, particularly when updating existing scenes acquired from different sensors. Many authorities demand as-built surveys to prove the placement of a facility at a specific moment in time. These are vital for the site's upkeep and future expansion. A total station was employed to accomplish this task in the past, but it is more expensive, time consuming and requires more qualified surveyors to complete. The objective of this research is to examine the use of an Unmanned Aerial Vehicles (UAV) system for façade surveying in Sri Lanka. The findings demonstrate that the UAV's ability to produce as-built survey mapping, and that it also simplifies as-built survey work by saving time and eliminating the need for trained surveyors. As a result, UAVs are ideal for engineering tasks.

Keywords: *unmanned arial vehicle, orthomosaic, Structure From Motion (SFM)*

Factors Affecting the Implementation of E-Procurement for Government Sector in Sri Lanka

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Procurement is known as a substantial instrument in both public and private sector organisations. However, the manual procurement system creates considerable issues, and it can affect the country. Therefore, the countries are tempted to implement the E-Government Procurement (E-GP) system since it helps to generate an income more effectively. E-procurement was built to reduce corruption and conspiracies, increase public accountability, and enable the purchase of goods and services in a more effective, efficient, and affordable manner. The main purpose of this study is to measure the relationship between E-GP implementation and technology, organisational and environmental factors. The population for this study included procurement divisions in Departments, State Managed Boards, Authorities, Commissions, Corporations, Bureaus, Institutes and Institutions, and Government Banks. Data were collected via a cross-sectional questionnaire-based survey. Relevant respondents were chosen from a sample of 162 firms using a convenient and random sampling techniques. This resulted in an overall response rate of 43%. This study uses quantitative research methods to identify the variables affecting the adoption of e-procurement. All variables from technology, organizational and environmental contexts are positively correlated with the dependent variable of E-GP implementation. Results revealed that human capacity and awareness was the most important factor. This study suggests further researches to determine other independent factors which influence implementation of electronic procurement.

Keywords: procurement, promise system, E-GP implementation

Impact of Material Management on Cost Overruns in Construction Projects in Sri Lanka

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The construction industry is considered to be a main contributor for the development of an economy of a country. In Sri Lanka the contribution of the construction sector plays a major role towards the economic growth. Meanwhile, cost overruns are inevitable consequences within the construction industry, and material management is identified as one of the key causes for cost overruns within construction projects. Relationship between material management and cost overruns was not investigated much in conjunction within the Sri Lankan construction industry in past studies. In that sense, this study aims to identify the impact of material management on cost overruns in the construction projects in Sri Lanka. Moreover, issues and solutions for proper material management in construction projects were identified as the key findings in this study. The study was conducted as a mixed research approach where both qualitative and quantitative data were acquired through questionnaire surveys and semi-structured interviews. The impact and relationship of material management and cost overruns were identified via regression analysis and correlation analysis with the aid of SPSS software package. The issues and solutions for proper material management were identified through the manual content analysis. The major issue of material management was identified as the wastage of materials in construction sites. It causes high additional costs in construction projects. Finally, the study further elaborates the conclusions and recommendations to overcome cost overruns through proper material management in construction projects in Sri Lanka.

***Keywords:** material management, cost overrun, construction projects*

Specialized Software Usage among Quantity Surveryors in Sri Lanka

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In the construction sector, the role of the Quantity Surveyor (QS) is critical because of the constant review of designs in our construction industry. Many software configurations have emerged in the market as a result of technological advancements that resolve current challenges. The objectives of this study were to identify the level of specialised software usage among quantity surveyors, determine the barriers to adapt advanced QS-related software in QS practice, determine the benefits of specialised software usage and to determine the strategies for overcoming the barriers to implementing advanced QS-related software. Data were obtained through ten interviews and fifty questionnaire responses to achieve these objectives. 70 questionnaires were distributed for data collection and 50 responses were obtained, resulting in a response rate of 71.42%. The study found that MS Excel and Auto CAD are the software most often used by Quantity Surveyors in Sri Lanka. The main sub barriers were the installation cost of the software, lack of experience with the software, and the lack of senior and firm support. Major benefits identified were the high speed, increased productivity and accuracy.

Keywords: *QS-related software, quantity surveyors, Sri Lanka*

Barrier Analysis to Implement Building Information Modeling (BIM) Execution Plan in Sri Lankan Construction Industry

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Building Information Modelling (BIM) can render significant advantages to the project team. BIM can be used to improve a project's delivery and usage throughout its life cycle. The concept of BIM is currently being used in the construction industry worldwide. Currently, technologies such as 3D, 4D and 5D BIM are being used in the construction industry. Further, many countries use a BIM Execution Plan (BEP). A well-conceived BEP on a BIM-enabled project makes sure that advanced design technologies are successfully deployed. In contrast, the BEP focuses on improving work and model flow throughout a project to promote specialised interests for each individual stakeholder. Currently, in the light of the benefits BEP offers, it is practiced all over the world, but due to the numerous obstacles, it is less common in Sri Lanka. This study examined current BIM techniques in Sri Lanka, BIM adoption in Sri Lanka, BIM awareness in the country's construction industry, how an execution plan can help with BIM implementation, the challenges to modify a BIM implementation strategy for the Sri Lankan construction industry and suggestions to overcome the identified barriers. Through this study, suggestions for removing the identified barriers are also acknowledged. Lack of understanding of the idea and its advantages, government support for traditional documentation approach and lack of knowledge were identified as foremost barriers for the successful implementation of BEP. Additionally, findings suggested that Sri Lankans must undergo cultural changes in BIM practices, understand difficulties, and raise awareness among thoseinvolved in the construction industry.

Keywords: building information modelling, BIM execution plan, Sri Lanka

Potential of Architecture on Therapeutic Educational Spaces for School-Aged Children with Autism Spectrum Disorder in Sri Lanka

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Autism Spectrum Disorder (ASD) is a neurodevelopmental condition known by deficiencies in social communication and the expression of repetitive or/and unusual behaviours. The prevalence of ASD today is getting high while affecting a significant percentage of the population of Sri Lanka. Hence, implementing a processed institutionalizing plan for the condition could become more relevant presently. This study explores the significance of applying specific spatial design approaches to accommodate mainstream and special education classrooms in the Sri Lankan educational context. Moreover, it seeks the awareness of Sri Lankan Architects on ASD and its association with spatial attributes in creating therapeutic learning environments for children with ASD in Sri Lanka**.**

Keywords: *ASD, autism, spatial healing, therapeutic educational spaces, autism-friendly architecture*

Preventive Measures for Fire Accidents in Apartment Buildings in Sri Lanka

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Owing to the significant increase in population, the lands have become scarce. Therefore, the prices of land also have increased. To address this issue, people tend to buy apartments instead of individual land plots to construct a house. The height and the complexity of these residential buildings may easily lead to fires and there will be property losses, injuries, and deaths worldwide every year. Hence, nowadays people are concerned about the safety from fire in all these apartments due to these incidents. The aim of this research is to identify a better preventive measure for fire accidents in high-rise residential buildings in Sri Lanka. An extensive literature review was carried out to discover the current practice in worldwide fire prevention. This study was conducted using a questionnaire survey with apartment building occupants to identify the fire safety measures currently being practiced in the Sri Lankan context regarding the ICTAD fire regulations. Simultaneously, the statistical data relating to fire incidents in Sri Lanka for the past few years and major reasons for SL apartment building fires were collected from the fire department. The collected data were analysed based on 3 building height categories. From the findings, faulty wirings were identified as the major reason for apartment fires. Most occupants are unaware of fire safety regulations, and also some of the buildings are not facilitated with required fire safety measures. Finally, it is strongly recommended to conduct demonstration programmes for public awareness and to practice fire safety regulations.

Keywords: apartment buildings, fire regulations, high-rise buildings

Investigating the Potential of Using an Alternative Finishing Material for CounterTop Construction as a Cost-Effective Solution

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Current economic situation, material price hike and shortage of materials have directly and indirectly caused an unprecedented price increment in finishing materials and total cost of construction, specially in finishing stages. Therefore, finding alternative materials that are cost effective without sacrificing quality and appearance has become a vital need. With the popularisation of an open kitchen and open pantry concepts, countertop construction has gained more attention in terms of the aesthetics and appearance as well as function. Thus, a research series was initiated with the aim of investigating the feasibility of the ferrocement as an alternative material for countertop construction while maintaining the intended appearance and functional requirements. The paper presents the findings of the initial stage of the research conducted to assess the cost effectiveness of the proposed alternative material prior to further experimentation on material development. An onsite experiment was carried out to construct a prototype countertop and check the feasibility of construction. Ferrocement panel with a dimensions of 1200mm X 600mm X 20 mm was cast for the study. Epoxy coating was applied on ferrocement body to achieve desired water absorption rate and aesthetic appearance of the final product. Since the prototype construction was successful, a cost comparison was conducted. The total production cost was calculated and compared with same size conventional granite countertop construction. Accordingly, sq.ft rate of ferrocement countertop was calculated to be Rs. 1536.08. Results showed that 41.7% cost saving could be achieved while keeping the desired aesthetical qualities and water absorption limits. This could be a feasible alternative for countertop construction in Sri Lanka.

Keywords: *countertops, ferrocement, cost effective materials*

The Impact of Urban Morphological Transformation on Legibility of Old Neighbourhoods with Special Reference to Old Colombo-Kandy Main Road in Mawanella

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Mawanella is a small suburb in Sri Lanka that has been developed as a transitional town since the colonial period. The historical layers of the town were reflected as traditional buildings on either side of the old Colombo-Kandy main road. The development of road widening projects resulted in drastic changes to the existing urban form and many old settlements were erased by uncontrollable development, practiced during the last 20 years. The study explores how the gradual changes in urban morphology impact on legibility of older neighbourhoods, considering Mawanella as a model case. The literature review synthesised the parameters such as the pattern of urban morphology, serial vision along the main artery and the façade articulation to study the transformation of the city form. The methodology was adopted to identify the aspects that contribute to the city's identity, how the urban morphology has been transformed over the last 20 years and how it impacts city legibility through visual survey and a perception study. The research confirmed that people were strongly attached with the old city elements and the unique morphology of the old neighbourhood which visually and physically contributed to achieve the city legibility though currently, it was unable to gain through the modernised environment. The outcomes of the study were formed as an urban design toolkit, to be used for future developments of older neighbourhoods.

Keywords: *urban transformation, morphology, urban grain, serial vision, perception, urban form, old neighborhoods, legibility*

An Investigation of the Resource Finding Issues in Highway Construction Projects in Sri Lanka with Covid-19 Pandemic Situation

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The construction resources are essential for the functioning of construction projects consistently up to their finishing stage. In this regard, construction resource planning and management are compulsory to realise project goals on time and to accomplish them within the budget. The whole construction industry of Sri Lanka was affected by the COVID-19 pandemic outbreak and most construction projects had to face difficulties in effective resource management. The research approach is to investigate resource finding issues that arose with the COVID-19 pandemic with reference to four highway construction projects in Sri Lanka. The study also focused on identifying the effects on project completion on time, cost and quality. Through the literature review, seventeen resource finding issues and related factors were identified under three categories, which are human, material and financial. Then, the importance level of identified factors were justified to this particular study through the responses gathered using a questionnaire survey. The responses were taken from construction professionals (project managers, planning engineers, construction managers, QA/QC engineers, quantity surveyors and site engineers) who were selected according to the researcher's judgement from four contractor firms. Then factors were analysed and ranked using Relative Importance Index (RII) and descriptive statistics, utilising Excel and SPSS software. The results presented that all factors significantly affected resource finding issues and showed their effects on project delays, cost and quality. Finally, the research concluded with identified effective solutions for continuing highway construction projects during COVID-19 pandemic period.

Keywords: *resources, project objectives, highway innovation, Covid-19*

Existing Sustainable Features in Sri Lankan Road Construction

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One of the world's greatest natural resource exploiters relies on the building and materials sectors for physical and biological support. The concept of sustainable development has been around for more than 30 years, and it connects development and the environment. The road industry emits the most amounts if greenhouse gases, both directly and indirectly, due to the usage of fossil energy in mining, transporting, and paving operations. As a result, road development contributes significantly to the pollution of Sri Lanka's environment, and as the success of environment-friendly road construction is not at a sufficient level, mainly a low level of attention is given to sustainable development in Sri Lanka. Hence, this research focuses on enhancing road construction success through a better understanding of sustainable development. An extensive literature synthesis was carried out to review the concept and key features of sustainable road construction globally and with reference to Sri Lanka. Following that, an expert interview and a survey were used to continue the study using a mixed research approach. Expert interviews and questionnaire surveys were conducted as data collection methods. The data analysis was conducted through manual content analysis and Relative Important Index (RII) techniques. The findings revealed the existing sustainable features in Sri Lankan Road construction and their advantages and disadvantages. The challenges and opportunities of Sri Lankan Road construction for sustainable development were identified. Thus, the applicability of existing sustainable features to Sri Lankan Road construction shall be reviewed further in empirical research.

Keywords: *road construction, sustainable features, Sri Lankan road construction*

Challenges Encountered in Teaching English in Rural Sri Lankan Secondary Schools: A Case Study of Bandaranayake Secondary School in Kiriibbanwewa, Moneragala District

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English language competency is a necessary skill in Sri Lanka. With this in mind, successive governments have implemented various approaches to strengthen English Language Education in the rural outskirts of the country. These initiatives include projects like 'speak English our own way' and attempts to recruit candidates as teachers with higher diplomas in English in order to address the dearth of qualified English teachers. However, it is unclear to what extent these efforts have been successful. This study sets out to examine the challenges encountered in English teaching and learning in rural parts of Sri Lanka today, taking Bandaranayake secondary school in Kiriibbanwewa, Moneragala District as a case study. Data was collected through ethnographic research methods utilising qualitative observational data and semi-structured interviews, and was then analysed using thematic analysis. Findings demonstrate that students at Bandaranayake secondary school, regardless of their grade-level, lack basic English proficiency beyond an A1 level. This language outcome is a result of teaching methods that prioritise textbook-based reading and writing over speaking and listening skills, while emphasising accuracy over fluency. In order to address this gap between English language Teaching (ELT) methods and outcomes, researchers recommend conducting ELT training for English language teachers in rural secondary schools through tertiary educational institutes local to the area.

Keywords: *English, language, education, rural, secondary schools, Sri Lanka*

Implementing 6R Principles of the Circular Economy Concept in Sri Lankan Construction Industry

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This study is focused on implementing 6R principles of the circular economy concept in Sri Lankan construction industry and provides a criteria that can be applied to uplift the adaptation towards the circular economy concept in construction projects. Circular economy concept in the construction industry can be considered with the application of sustainable construction approaches to the whole construction process, from material extraction through building and infrastructure planning, design, and construction, as well as the ultimate demolition and the waste disposal. The purpose of the circular economy concept is to create economic strategies that allows to regenerate the materials, resources, and components while retaining their worth for as long as feasible. There is a set of principles in the circular economy concept that have been identified in the literature, called 6R principles, i.e. reduction, reuse, recycle, redesign, re-classification and renewability. A qualitative data collection approach was followed to collect data and the semi-structured interviews were conducted among construction professionals. It was highlighted at the interviews that the circular economy concept is a very new concept not very popular in Sri Lanka, and the applicability of the principles of circular economy is in the initial stage. Mostly, 3R out of 6R (reduction, reuse and recycle) principles have been applied for some of the mega-scale sustainable construction projects and the 6R principles are very new to the Sri Lankan construction industry. Lack of awareness on sustainable concepts like circular economy among construction professionals, their willingness to follow traditional project management practices and consideration only on the initial cost of a project and not on its life cycle cost are the barriers highlighted at the interviews.

Keywords: *6R principles, circular economy, construction industry, sustainability*

POSTER PRESENTATIONS

Spatial Pattern of Urban Expansion and Green Spaces: A Case Study of Tangalle Area, Sri Lanka

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Urbanisation responds to urban expansion and changes in green spaces. Moreover, urban expansion has a significant impact on urban management. Urban forests (Green Spaces) provide benefits of the natural environment to communities. Recognising the spatial pattern of urban expansion and green spaces within a certain time period is vital for urban planning. This study examines the expansion in Tangalle town. Built-up expansion has occurred in recent years because of the tourism industry in this study area. The remote sensing indices, Normalised Difference Built-up Index (NDBI) and Normalised Difference Vegetation Index (NDVI) have been used to extract built-up and green spaces for identifying the spatial pattern changes from the years 1990 to 2021. According to the results of the urban expansion/sprawl index, urban areas been expanded slightly between the years 1990 and 2000, but it has decreased between the years 2000 and 2010. However, between 2010, and 2021, the urban area has sharply expanded up to 13%. The study revealed that the built-up area has increased enormously. NDVI shows that the increase in this built-up area has led to a decrease in significant agricultural lands and open spaces. Thus, in the year 1990, the urban form was an isolated urban pattern and it gradually became a cluster-based pattern. According to the urban expansion results, the urbanisation is expanding towards the northern direction from the city center.

Keywords: *urban spatial pattern, Normalised Difference Building Index (NDBI), Normalised Difference Vegetation Index (NDVI)*

A Case Study on Detecting and Mapping Individual Coconut Trees Using YOLOV3 in Conjunction with UAV Remote Sensing for Smart Plantation Management

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Location and number data of individual coconut trees are important for surveying of planting areas, predicting coconut yield, and managing and planning coconut plantations. This data is usuallyobtained through manual investigation and statistics, which is time-consuming and tedious. Deep learning object recognition models, widely used in computer vision, can provide an opportunity to accurately identify individual coconut trees, which is essential for rapid data acquisition and the reduction of human error. This study proposes an approach to identify individual coconut trees and map their spatial distribution by combining deep learning with unmanned aerial vehicle (UAV) remote sensing. High-resolution true-colour images of coconut trees at the Mahayaya Coconut Model Plantation in Sri Lanka were collected through UAV remote sensing, and an image dataset of deep learning models of individual coconut trees (ICTs) was constructed by visual description and field surveys based on coconut tree images captured by UAV remote sensing. YOLOv3 was selected to train, validate and test the image dataset of coconut trees. The results show that the average accuracy of the YOLOv3 model for validation reaches 91.7%. The number of ICTs in the study area was calculated using YOLOv3, and their spatial distribution map was created using the non-maximum suppression method and ArcGIS software. This study will provide basic data and technical support for smart coconut plantation management in Mahayaya coconut model plantation and other coconut-producing areas.

Keywords: *Individual Coconut Tree (ICT) detection, deep learning, YOLOv3, remote aensing, Unmanned Aerial Vehicle (UAV), spatial distribution*

Optimum Site Selection for Fire Brigade in Ella, Sri Lanka by Utilizing GIS

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As an island nation, Sri Lanka faces different disasters while the forestfire disasters are dominant in the highlands of the country. In the Ella neighbourhood, forestfires occur every year near the end of the dry season. Further, the absence of fire stations near the area is a considerable issue. After the investigations a suitable location for the forestfire brigade was found and the network connectivity to the selected location from any place of the Ella was analysed. To find the best placement for a fire station, a site selection analysis was performed in a GIS context via a weighted overlay analysis. As the data sources of the study population, land use, land cover, elevation, water sources, road, building, pre-fired area, and pre-hazardous areas were utilised in the ArcMap 10.5 software platform through spatial analysis tools and network analysis tools. For the determination of weights for each factor, the Analytical Hierarchy Process was used as the main statistical technique of the study. Finally, the selected areas were examined via visual validation in Google Earth, and the most suitable location for fire brigade establishment along with the network analysis was selected. In addition, the establishment of the fire brigade is crucial in the central part of the country due to the magnitude and the frequency of the disaster. Further, the proposed study can be utilised as a comprehensive guideline for any organisation before the establishment of the fire brigade.

Keywords: *analytical hierarchy process, forest fire, geographical information science*

An Assessment of RTK and PPK Solutions in a CORS Network

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Recently, Sri Lanka has developed a greater interest in surveying applications based on Continuously Operating Reference Station (CORS) technology. CORS Real Time Kinematic (RTK) can perform well through a good Global System for Mobile Communications (GSM) coverage area by receiving the corrections in real-time. It is very difficult when facing the GSM network coverage limitation issue in remote areas. As an alternative solution, Post Processing Kinematic (PPK) is a good solution to face this problem because it does not need a real-time data communication link for the correction signal when conducting the survey. This study aims to compare the RTK and PPK solutions in a CORS network in Sri Lanka. Seven known points were selected near the Belihuloya area. The CORS reference station was the SULECO SUSL station. Position solutions were compared for both PPK and RTK methods with several sets of observations. According to the results, the horizontal variation of the PPK was as accurate as the RTK solution, which was below the 1cm mean difference. However, the vertical accuracy was lower than the horizontal accuracy in the PPK technique. This was around 10 to 15cm variations in the study area. In conclusion, both PPK and RTK techniques gave similar results in terms of horizontal accuracy in a CORS network. Therefore, the issues of real-time corrections transfer in a CORS network can be overcome by adopting PPK mode for the boundary and detail survey without interrupting the progress.

Keywords: accuracy assessment, CORS network, GNSS, PPK, RTK

Feasibility Analysis of Unmanned Aerial Vehicle Survey for Outer Boundary Surveys

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Cadastral surveying is the intellectual and technical process by which the boundaries of each of the land parcels within a given area are defined in a consistent manner. The main problems of the Sri Lankan cadastral system are the increased time consumption, high cost and inefficient methods for data acquisition. In cadastral surveying mainly there are three operations, i.e. determination of boundaries, survey of boundaries, and the demarcation of boundaries. This paper presents a modern method of close-range photogrammetry using Unmanned Aerial Vehicle (UAV) as a solution in the scope of determining and surveying boundaries. This study analyses the capability of UAV surveys to function as a rapid, cost effective and accurate alternative to current data acquisition techniques in the hope of accelerating the cadastral mapping process of the country. The accuracy of UAV to survey outer boundaries was measured by comparing land extents of typical land parcels obtained via two methods, UAV and Total Station (TS). The results of this study show the point cloud generated from UAV images generate a similar extent output as conventional methods. The only limiting factor was boundary visibility which was not an issue in the research scope. The advantage of UAV systems lies in their high flexibility and efficiency in capturing the surface of an area from a low flight altitude.

Keywords: *boundary detection, cadastral surveying, mapping, surveying, total station, unmanned aerial vehicle*

Mapping the Pattern of Distribution of Threatened Marine Species from the X-Press Pearl Ship Explosion Using GIS Techniques

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Over 90% of global trade is done by shipping, and thus, the marine sector supports the transportation of a variety of critical items while balancing the global economy and keeping countries united in such a complex global market. Sri Lankan ports are strategically positioned ports for vessels going from west to east and east to west. The X-Press Pearl ship explosion recorded on the 20th of May 2021 was investigated under the study by utilising the Geographic Information Systems in the spatial domain. It severely polluted some of the coastal zones of Sri Lanka including Colombo, Kalutara, and Galle due to its chemical explosions and oil spreading. Under the research, we explored the marine species 'wash-out' incident through records and reports on social media and news reports as the main source of data. First, all data is stored in the spatial database before the analysis and along with the location coordinates. Then, the spatial analysis was carried out in the Arc GIS 10.5 platform and maps were generated to illustrate the pattern of expansion. According to the study, it has found out that the most vulnerable areas were Western and Southern coastal regions while some incidents were recorded in the Eastern part as well. The data collected and reported on social media or news was utilised in the data collection phase, and it indicates the public involvement in disaster management practices. Further, data analysis done through the GIS context would be significant in the decision-making and implementation phases as a future direction of the study.

Keywords: *coastal, GIS, marine pollution*

Spatial Analysis Approach for Identification of Urban Sprawl Pattern: A Case Study of Matara DS Division

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In this study, the urban sprawl of Matara DS Division was analysed from 1990 to 2020. Landsat satellite imageries were used in this study to extract the built-up area. Shannon's Entropy method and Fractal Dimension of Box Counting method were used to analyse urban sprawl. NDBI was used to extract the built-up area from Landsat TM/ETM+/TIR satellite imageries which are necessary for calculation of both methods. A number of grids coinciding with the built-up vector layer had been used to calculate fractal dimension. The accuracy assessment shows an accuracy more than expected (above 80%). Additionally, built-up area has changed by a huge number. An area of 1.097 km^2 is shown in the year1990, and in the year 2020, it was shown as 11.669km^2. Shannon's Entropy was increased from 1990 to 2020 from 1.23 to 1.67, and the year 2000 showed 1.46 while the year 2010 showed 1.52. It has increased gradually and reached error range (>1.5). Fractal Dimension also was increased from 1990 to 2020 from 1.24 to 1.65 and year 2000 showed 1.498 and year 2010 showed 1.520. It 28as also reached to error range (>1.5). Hence, these results proved that urban sprawl has increased in the study area and the Shannon's entropy calculation categorised a high sprawl, sprawl and no sprawl. Isadeen town, Kadawediya East, Kadawediya West, Kotuwegoda North, Kotuwegoda South, Mathotagama, Noope, Uyanwatta, Uyanwatta North, Welegoda East, Welegoda West, Weliweriya East, Weliweriya West GN Divisions are identified as high sprawl GN Divisions. There is a close relationship between Shannon's Entropy and Fractal dimension method as revealed by the graphical representation. Finally, this study identified the pattern of urban sprawl such as low-density development, commercial strip development andscattered and dispersed developments in the study area. The result revealed that, in the year 1990, only scattered development happened in the study area. But when it came to 2020, it showed 3 development patterns of urban sprawl and didn't show leapfrog development.

Keywords: *urban sprawl, dimension, Shannon's entropy, landsat*

Shoreline Change Detection Based on the Monsoon Seasonality by Means of 'Coastsat' Toolkit

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The sand accretion/erosion process is mainly responsible for the shoreline position changes in coastal zones. Understanding sand accretion/erosion response due to monsoon seasonality and anthropogenic effects is vital for coastal management to apply the best suitable coastal protection strategies. However, long-term monitoring of shoreline changes is expensive, time-consuming and labour-intensive. Instead, satellite imagery (Remote sensing technology) can be utilised as a substitute method to the field data collection, provided that time-series imagery is obtainable at the same location and freely downloadable using the Google Earth Engine archive. This study is mainly focused on shoreline change detection and geomorphological changes, Mirissa in the Southern coast of Sri Lanka. The 'CoastSat' software was employed to obtain the time-series of shoreline positions. According to the analysis of data, the beach was in 3 states: erosion, accretion, and steady state. Further, most of the transect locations indicate a steady beach state and it is good for the development of tourism industry. In addition, the average horizontal shoreline difference ('CoastSat' and field measurement) was 7.95±1 m and that is in an acceptable range. Accordingly, satellite images downloaded from the Google Earth Engine using 'CoastSat' can be used to analyse shoreline change detection very effectively with appropriate tidal correction when there is a lack of long-term field data in the area, and it will be very useful for planning and evaluating coastal management strategies.

Keywords: *accretion, coastsat, erosion, shoreline*

The Effectiveness of Health & Safety Training and Its Impact on Construction Workers' Attitudes in Sri Lanka

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Construction accidents happen due to defects in site environment or else defects in health and safety system. In the recent years, Sri Lankan construction industry experienced a considerable number of fatal and non-fatal accidents. Occupational health and safety training can be applied as a precautionary action to reduce work site accidents. The construction workers attitude towards health and safety training is essential to make it more practical. The main objective of the study was to study the effect of occupational health and safety trainings and its impact on worker health and safety attitudes. Both qualitative and quantitative methods were applied to achieve the objectives. The data collected through questionnaires consisted with close-ended questions and five Likert scale questions and semi-structured interviews. The degree of application on health and safety training was analysed through frequency analysis. Further, the relationship between health and safety training and workers attitude and the barriers on implementing health and safety training were analysed through correlation and regression analysis. Finally, the solutions to reduce work site accidents were analysed through content analysis. According to these analysis, results proved that there is a positive relationship between health and safety training and construction workers attitude in Sri Lanka. Conducting high-engaging health and safety trainings, conducting health and safety meetings and inspections, rewarding and appreciations and managerial support were the results of the interviews to enhance the workers attitude on safety.

Keywords: *health & safety training, construction worker, attitude, Sri Lanka*

The Impact of Cost Overrun Factors on the Project Performance in the Construction Industry of Sri Lanka

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The construction sector is an extremely vital business for the economic growth of the nation. However, this sector has been suffering significant issues by the inability to finish projects within an allowed cost and cost overrun affects the total project performances. Hence, this study determines to identify the impact of cost overrun factors on the performance in the construction industry of Sri Lanka. As an outcome, the findings of this study give recommendations and solutions to cost overrun factors that affect the performance of a project in Sri Lanka's construction sector. The aims of this research were attained utilising qualitative and quantitative data acquired through a comprehensive questionnaire survey and semi-structured interviews concurrently. The sum of circulated questionnaires was 50 and the number of responses was 90%. A detailed literature survey was carried out to establish the significant cost overrun factors that affect project performance. Correlation & regression analysis was conducted with the use of SPSS software to analyse the collected data. The interviewed questions were assessed through the content analysis. The findings of this study explain that the cost overruns have a major effect on project performance. Finally, solutions such as shifting to digitalisation, selecting the best construction management team and employees, properly tracking and monitoring progress, developing employee skills and maintaining a sustainable supply chain were found to be effective in overcoming the cost overrun factors that have an impact on the performance of Sri Lankan construction industry.

Keywords: *cost overrun, project performance, construction cost, construction industry*

Challenges Allied to the Effectiveness of the Environmental Impact Assessment in the Construction Industry of Sri Lanka

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'Environmental Impact Assessment' is a structured programme for evaluating and inspecting environmental factors, in order to support and aid the decision-making or the planning stage of a development process. Basically, this information is used to observe the change caused to the environment due to the development process and advice the most effective and reasonable methods to reduce the impact to the environment. Considering the last decade, Sri Lanka has been positive towards development and towards the construction industry. Nevertheless, there are numerous environmental concerns that should be addressed due to these developments. EIA procedure emphasises the possible environmental impacts and methods to reduce these impacts. This study elaborates on the challenges allied to the effectiveness of the environmental impact Aassessment in the construction industry of Sri Lanka. The impacts of five main challenges are discussed in this study and also the study will provide an insight into the current EIA procedure implemented in Sri Lanka. Both quantitative and qualitative approaches are used to collect data, and these collected data were presented using both numerical formats by regression analysis and descriptive formats by content analysis. The findings in the study reveal that the challenges discussed in this study have a significant impact on the effectiveness of the EIA procedure. The paper concludes with recommendations or strategies to overcome these challenges.

Keywords: environmental impact assessment, challenges, strategies, construction industry, Sri Lanka

Analyzing Factors Affecting the Delay in Building Construction Projects in Sri Lanka through the Interaction of the Project Team

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Constructions undergo unfavourable situations related to their cost overruns due to the delays and exposure to risks because of inappropriate identification and minimising of the factors. To fulfill this gap, the research has analysed factors affecting the delay in building construction projects in Sri Lanka through the interaction of the project team with an adequate understanding on the practical solutions for minimising relevant factors. The study has used a mixed approach of qualitative and quantitative techniques for the identification of factors, and a review of literature was done. To assess the factors affecting delays, a questionnaire was distributed among 40 professionals in Sri Lanka and the analysis based on the Relative Important Index (RII)identified that client related factors, contractor related factors, consultant related factors and other related factors and assessment of the factors that affect the building construction industry. Significant factors of building construction delays were identified such as poor communication and coordination, delays in obtaining approvals from government regulated bodies and delays in subcontractor activities, inexpedient scheduling and project planning, inefficient contractor work and unexpected subsurface conditions and unforeseen circumstances. The study identified that the contractor related category had the highest affect as a result of delays of construction industry in Sri Lanka. To identify practical solutions for minimising, interviews were conducted by selecting 10 professionals with more than 10 years of experience as the sample. Concerning more on the effective performance of the key stakeholders under a better management system is recommended in minimising the problem of increasing delays, which will help to ameliorate performance issues of the industry.

Keywords: *delays, building construction, Sri Lanka*

Foreign Funded Construction Projects in Sri Lanka: Review Challenges on Technology Transfer with Local Stakeholders

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Technology is an integral part of the construction industry and a dominant factor related to cost. Most of the modern materials, plant, equipment and services are innovated by developed countries and their aim is transferring them through funding facilities to other countries. Sri Lankan government intends to obtain foreign funds in order to develop most of the infrastructure and buildings in order to cater for economic growth and living standards which would result in some socio-economic issues in the present situation. One of the positive outcomes on foreign funding is the technology transfer. The study aims to define the potential impacts and to assess them to cater for better decisions in future endeavours. The direct population was stakeholders who are in construction projects and selected sampling (experts) was by snowball technique. Quantitative and qualitative methods were applied for data collection in the mode of questionnaire and semi-structured interviews. The SPSS computer software was applied in order to check validation of data and to give reliability of findings. The content analysis had been used for synthesis evaluation. The literature review shows positive effects as well as potential negative effects on foreign technology transfer on other countries as well. The outcome of findings reveal that arrival of modern goods, latest methods of execution, sophisticated computer software modelling and simulating, innovative management procedures as consequences of the positive impact. Development in supported industry (example, e-commerce in legal trade) and upgrading is required on education on theory and training, the lack of which derives a negative impact on technology transfer. Finally, the recommendations have been put forward to minimise the areas with potential negative impact and to identify more cost opportunities in positive impact areas in stakeholders' future projects.

Keywords: *technology transfer, impact assessment, economy growth, foreign funding*

Sustainable Tourism in Hikkaduwa; Evaluations of Sustainability Parameters and Design Recommendations

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This research intends to identify the factors that influence the tourism industry of the Hikkaduwa coastal area and to give an overall architectural guideline to implement sustainable tourism. At present, rapid and unsustainable development of the Hikkaduwa area has caused different kinds of environmental, economic and social issues. Many of those cases have been identified and studied on coastal tourism, sustainable parameters and existing regulations related to urban planning to give out solutions. Based on these studies, a case study was done for identifying the special characteristics of Hikkaduwa for modifying and adjusting the parameters that are fitting for Hikkaduwa. While following these parameters, the study has proposed a suitable design guideline for the overall Hikkaduwa study area. These proposed parameters and guidelines are supportive to the existing regulations and these architectural solutions have been implementing the criteria for sustainable development automatically. Therefore, the study contributes new knowledge for achieving sustainable development and creating a city on sustainable tourism.

Keywords: *sustainable development, design guidelines and parameters, coastal tourism*

Contribution of Green Buildings towards Achieving Sustainability: A Perspective of Leed-Certified Buildings in Sri Lanka

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Recently, the focus on green buildings has come to the forefront in many countries. However, in the context of Sri Lanka, the number of green-certified buildings seems to be still at a minimal level and the focus is solely on the energy efficiency features. Although green buildings are meant to be sustainable, the level of incorporation of sustainable features and their contribution to sustainability is questionable. Therefore, the current study aims to examine the extent of incorporation of sustainable features in green-certified buildings in Sri Lanka. A review was conducted into the USGBC database and the profile of green-certified buildings in Sri Lanka was examined to identify the extent of green certification in Sri Lankan buildings and their level of achieving sustainable features. The reasons for the level of achievement of those sustainable features were then identified by interviewing professionals who engaged in green buildings. Accordingly, the selected buildings have over 80% of achievement in terms of water efficiency and sustainable sites, while other design features such as energy and atmosphere, indoor environmental quality, and material and resources are achieved below 50%. Further, energy and atmosphere, and indoor environmental quality features require alternatives with higher initial cost, early commitment, and an integrated design process. Most of the time, energy and indoor environmental quality features seem easy to achieve, but often turn out to be far more complicated, and thus less feasible, than anticipated. Knowing sustainabe achievement of features would enable green building investors to select the most appropriate features for a given construction.

Keywords: *green building, leed certification, sustainable features, sustainable development, Sri Lanka*

Investigating the Potential of Utilizing Simulation Studies to Identify UHI Mitigatory Strategies in Proposed Cities

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Rapid development of urban areas catalysed the movement of people from rural areas to urban areas. This led to the demand for more dwelling places. Urbanisation and industrialisation caused the replacement of permeable land cover into impermeable materials. More solar radiation is absorbed by impermeable materials as it has thermal bulk properties and causes for the increase of urban temperature. Change in urban microclimate causes the phenomenon to be identified as urban heat island effect, which is identified from the temperature difference between urban and rural areas. In Sri Lanka, a few researches have been conducted on UHI effect for developed and existing cities. Identifying potential UHI mitigatory steps is vital when designing urbanities. Therefore, analysing UHI effect and possible mitigatory strategies for proposed cities through simulation studies are highly beneficial in developing sustainable cities. The research focused on investigating the potential of utilising simulation studies to identify UHI mitigatory steps for proposed cities in local context. Rhino 3D simulation software was utilized for the study. The paper presents the results of initial studies conducted. Research methods and workflow developed through the study can be utilised to evaluate the UHI effect, mean radiant temperature (MRT) and universal thermal climate index (UTCI) to identify outdoor thermal comfort. This software and methodology can be used for future developments to identify the UHI effect as a result of the completion of the project and mitigation methods that can be used to negate the UHI effect and enhance human comfort.

Keywords: urban heat island effect, outdoor thermal comfort, Rhino 3D

Investigating the Thermal Comfort and Well-Being of Differently Abled War Veterans' Housing in Sri Lanka

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Wellbeing in the indoor built environment has become a crucial research topic in relation to thermal comfort which helps to improve sustainable built environments. Thus, thermal comfort requirements for humans is the main consideration in building design. It is important to consider comfort and wellbeing of people with physical disabilities. Thus, this research was conducted to investigate the indoor environment quality of spaces in relation to the 'thermal comfort in physically disabled war veterans' housing in the Sri Lankan context. An on-field investigation was carried out to obtain physical measurements of microclimatic parameters of interiors including indoor temperature, relative humidity and air velocity. Secondary data were collected through semi structured interviews. Results explicitly prove that the mean value of the operative temperature is 32.2°C, which is above the ASHARE 55-2013 standard for comfortable thermal conditions. Mean wind velocity is 0.25m/s, is low, as there is a high operative temperature adequate interior ventilation needs to be provided. The Humphries comfort equation states the required comfort temperature is 28.92°C, but the obtained mean operative temperature is more than this comfort temperature, which proves that the interiors are overheated. The most common adaptive behaviour of the veterans are switching fans on and moving toward open spaces. Results also indicate that there is a psychological link with thermal adaptive behaviour as these veterans opt to remain in free outdoor spaces rather than in confined spaces as their battlefields. Thus, this research paper highlights on the thermal conditions needed for interior spaces for disabled war veterans and in the long-run contributes to regulations to add developments to the National Policy on Disability in Sri Lanka.

Keywords: *thermal comfort, physically disabled people, indoor built environment*