2023 SRS FBESS

FRC FBESS

# STUDENT RESEARCH SYMPOSIUM

*"Exploring Creative & Innovative Building & Construction Technologies towards a Sustainable Built Environment"*

27TH JULY 2023

## EXTENDED ABSTRACTS

### BUILT ENVIRONMENT AND SPATIAL SCIENCES

FACULTY RESEARCH CELL
FACULTY OF BUILT ENVIRONMENT & SPATIAL SCIENCES

STUDENT RESEARCH SYMPOSIUM 2023

27TH JULY 2023 | SOUTHERN CAMPUS

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# STUDENT RESEARCH SYMPOSIUM 2023

*"EXPLORING CREATIVE AND INNOVATIVE BUILDING AND CONSTRUCTION TECHNOLOGIES TOWARDS A SUSTAINABLE BUILT ENVIRONMENT"*

**FACULTY OF BUILT ENVIRONMENT AND SPATIAL SCIENCES**

# EXTENDED ABSTRACTS

SOUTHERN CAMPUS
GENERAL SIR JOHN KOTELAWALA DEFENCE UNIVERSITY
SRI LANKA

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# Message from the Vice Chancellor

I am extremely delighted to convey my greetings to the proceedings of the 02nd Student Research Symposium (SRS), organised by the Faculty Research Cell (FRC) of the Faculty of Built Environment and Spatial Sciences (FBESS) of General Sir John Kotelawala Defence University, Southern Campus. The SRS provides a platform which brings together not only graduates, but also undergraduates in Architecture, Quantity Surveying and Surveying Sciences. With this platform, the SRS will embark on a vital role in showcasing student research work and engagement which will pave the way towards national development on a holistic level.

The theme of the symposium "Exploring Creative and Innovative Building and Construction Technologies towards a Sustainable Built Environment", exemplifies the necessity to integrate sustainable practices in the economic and social context of the marketplace. Therefore, I believe that this symposium will strive to impart quality research standards to meet national and global challenges. For undergraduates, it represents a certification of competence and a springboard to enhance their research skills as their contributions in the field of research plays an integral role in uplifting the research culture of General Sir John Kotelawala Defence University.

I expect that the SRS will promote strong collaborations among academics, practitioners and students, as vital links are created through the research work discussed. The path towards sustainable national development cannot be fulfilled by one sector, rather, all sectors of the community need to join forces in achieving sustainable enhancement. Thus, I believe that this symposium will be a prime example which proves that our graduate students possess excellent academic scholastic achievements, aided by the support of expert academics in the faculty.

I express my sincere gratitude to Rector of the KDU Southern Campus, Major General LCR Jayasuriya, the Dean of the Faculty Dr. AH Lakmal and members of the Faculty Research Cell for successfully organising a symposium of this calibre. I am confident that this symposium amply displays the research achievements of our students and on how the KDU is working diligently and promptly to provide leadership and resources for developing the next cohort of young re searchers for the country. With these few remarks, I encourage you all to merge yourselves into our research community and develop insights that excite the academic and professional work space in Sri Lanka and beyond.

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

# Message from the Rector – Southern Campus

Amidst the ongoing challenges brought about by the latest downfall in the economy of our country, we have glimpses of hope and good news, provided by the Faculty of Built Environment and Spatial Sciences (FBESS) of Southern Campus, General Sir John Kotelawala Defence University (KDU). A key component of FBESS's mission is to establish itself as a significant contributor of research in spearheading the economy of the country in terms of built environment. To achieve these attributes, the faculty has dedicated a research friendly working environment, funding facilitation and events such as conferences and symposiums.

As the Rector of the Southern Campus - KDU, I am delighted to witness and enthrall the 2nd Student Research Symposium (SRS) under the theme "Exploring Creative and Innovative Building and Construction Technologies towards a Sustainable Built Environment". The research work presented by the undergraduates demonstrated high quality scientific and creative research areas, which provide stepping-stone research contributions, leaning towards a sustainable way of living. Since the undergraduate students are the future of this country, their desire to learn and communicate their discoveries is mandatory to build a community of young budding researchers.

The commitment of the faculty academia and members of the Faculty Research Cell of the FBESS, needs to be appreciated in organizing this symposium. This symposium provided the undergraduates an opportunity to showcase their research knowledge on a wider platform. It furthermore allowed our undergraduates to pitch their research ideas, present their findings and receive feedback, providing them a glimpse into what they can expect in the real world. As we strive for excellence and innovation, I am privileged to lead a dedicated and connected community of undergraduates, faculty academia, military and civil staff. I wish them very best in all their future endeavors.

**Robin Jayasuriya RSP, ndc, psc**
Major General
Rector- KDU Southern Campus

# Message from the Dean – Faculty of Built Environment and Spatial Sciences

The Faculty of Built Environment and Spatial Sciences (FBESS), of General Sir John Kotelawala Defence University (KDU) Southern Campus, continues striving to enhance the research culture of the institution. Within this spectrum, the Student Research Symposium (SRS) organised by the Faculty Research Cell of the FBESS, is a celebration of the work of our undergraduates, showcasing their achievements in research. It also recognises the mentorship and encouragement provided for the students to achieve holistic results.

The proceedings of this year symposium constitute of research extended abstracts presented by twelve undergraduate students of the faculty. The quality of the abstracts has been affirmed and was assessed by a panel of experienced academics and an editorial committee. These students have worked diligently all year, and they are able to present their research findings through an oral presentation. The SRS, exemplifies FBESS's commitment to students, providing the opportunity to engage in research activities which helps them to discover and explore cutting edge research areas. The faculty places great importance on assisting students with their research projects as it develops their scientific skills, creative learning and thinking skills, communication skills, analytical skills and connects them to academics and professionals from diverse research disciplines. These acquired skills of our students will be taken forward to uplift their future postgraduate research attributes.

The achievements of our students reflect not just only their success, but also their unwavering commitment in the face of challenges. It is also aided by the enormous effort and guidance provided by their mentors of the faculty staff, who support and encourage these students. I express my sincere gratitude towards the members of the Faculty Research Cell, who have tirelessly worked hard to make this symposium a true piece of success.

**Dr. AH Lakmal**
Dean
Faculty of Built Environment and Spatial Sciences

# Message from the Chair – Faculty Research Cell

As the Chair of the Faculty Research Cell (FRC), Faculty of Built Environment of the Southern Campus General Sir John Kotelawala Defence University, it gives me immense pleasure to pen down my thoughts regarding the Student Research Symposium 2023 (SRS 2023). This is an event which aims to showcase and celebrate the remarkable achievements of our talented young student researchers. It is with great pleasure the FRC extends its compliments to all of you taking part in SRS2023.

This symposium provides a platform for students to display their innovative ideas, cutting edge research projects and insightful findings to an engaged audience of fellow students, faculty members and expert guests. It is through such intellectual discourse that breakthroughs are made and new frontiers are explored. Furthermore, it is an opportunity to sharpen the presentation skills of students, refine their research methodologies and gain constructive feedback from diverse perspectives. The SRS2023 will feature student presentations in a range of disciplines, reflecting and highlighting on the diversity of our faculty's research endeavours.

I would like to express my sincere appreciation to the faculty members and mentors who have played a pivotal role in guiding and nurturing these budding student researchers. Their mentorship and support have been instrumental in shaping the future generation of scholars in the respective disciplines. Moreover, I would like to commend my fellow members of the FRC for exceptional and tireless efforts in making this symposium a resounding success. It was evident that an incredible amount of hard work, dedication and attention to detail was put into planning and executing such as successful gathering of brilliant minds.

Finally, I would like to extend my best wishes to all the presenters, authors and participants, joining SRS2023 on site or online, and I hope you will find this symposium informative, inspiring and encouraging. Together, let us inspire and be inspired by the research conducted within our academic community.

**Dr. (Archt.) HT Rupasinghe**
Chair- Faculty Research Cell
Faculty of Built Environment Spatial Sciences

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# Message from the Keynote Speaker

I am delighted to have this opportunity to address a promising group of individuals who hold the key to a sustainable future and would be the future leaders of our country, to share this important message of sustainable construction materials and your vital role in shaping a greener world. I want to commend every one of you for pursuing a path that can make a positive impact on our planet as you have the power to change and create a sustainable built environment. Today, gathered here with a shared vision of progress and innovation, which is a call to action, to embrace curiosity, and to step out of our comfort zones, with the theme of "Exploring Creative and Innovative Building and Construction Technologies towards a Sustainable Built Environment" which encapsulates the belief of exploring sustainable pathways for a better living in the contemporary world. This can be done by investigating the architectural and scientific knowledge of sustainable building technologies.

Under my area of expertise, Sustainable construction materials lie at the heart of building a greener future. I therefore encourage you to delve into the realm of sustainable materials and embrace their potential in your studies and future careers, as we are at a decisive juncture where we must reconsider the materials we use, seeking alternatives that minimize environmental impact, reduce carbon emissions, and promote circularity. Stay informed and explore the latest advancements in sustainable construction technologies, as you can revolutionize the construction industry by shifting towards greener practices with recently witnessed advancements in sustainable construction materials with innovative solutions. Engage in interdisciplinary discussions and collaborate with experts from fields as it would widen your knowledge and create required innovative solutions for the complex challenges we face.

As future professionals, you have the power to advocate for sustainable construction practices. Investment in research and development, coupled with supportive policies and incentives can accelerate the adoption of sustainable construction materials. Thus, concern on the importance of sustainable materials, both within your academic institutions and in the wider community as it is crucial to stand in a regulatory framework to promote the use of environmentally friendly materials, set clear sustainability standards, and boost the development of new technologies. Be the change and inspire others to adopt environmentally responsible approaches to construction, seizing opportunities to gain practical experience in sustainable construction projects. Participate in internships, research initiatives, and community-based endeavors. By harnessing the power of innovation, collaboration, and purpose, we can create a built environment that aligns with our vision of a sustainable and resilient future. This hands-on experience will not only deepen your understanding but also equip you with the skills needed to implement sustainable solutions in real-world scenarios.

I express my utmost confidence in your ability to make a difference, shaping the future of the construction industry and contribute to a more sustainable world. Thank you for your dedication and may your journey towards a sustainable future be filled with endless possibilities and profound achievements. Let us seize this opportunity to transform the construction industry, one sustainable material at a time. Together, we can build a world that harmonizes the needs of humanity with the health of our planet.

**Dr. Malsha Shehani Mendis**
Senior Lecturer Gr.II
Faculty of Engineering
National School of Business Management (NSBM)

# Extended Abstracts

# A STUDY ON INDOOR THERMAL COMFORT IN CONDOMINIUM HOUSING SCHEMES WITH SPECIAL REFERENCE TO ELAPITIWELA HOUSING SCHEME WELISARA, RAGAMA

B.R. Weerakkody[#] and H.T. Rupasinghe

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## Introduction

Indoor thermal comfort is a crucial consideration in building design, as it directly impacts the satisfaction and productivity of building occupants. Ensuring that residents can maintain a comfortable living environment within their budget is particularly important in the context of affordable housing. Energy costs, especially those related to cooling, constitute a significant expense for buildings in Sri Lanka. By employing passive methods to achieve optimal indoor thermal comfort, it is possible to reduce energy consumption and, consequently, the overall cost of housing. This research aims to analyse the indoor thermal comfort of condominium housing, with a specific reference to how thermal comfort is influenced by the factors such as orientation, apartment height, surrounding vegetation, and proximity to other buildings. Elapitiwela Housing Scheme in Welisara, Ragama was chosen as the focus of this study, based on its unique characteristics that make it an ideal case for investigating indoor thermal comfort in condominium housing.

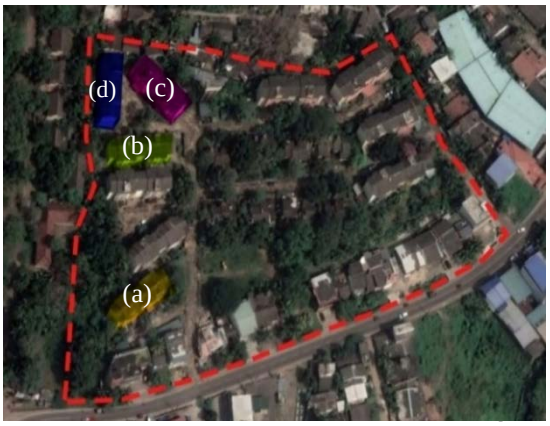


*Figure 1: Scheme layout with orientation*

The scheme comprises ten identical condominium blocks, each featuring distinct orientations, including north-south, northeast-southwest, northwest-southeast, and others. This arrangement provides a diverse range of building orientations, allowing for a comprehensive examination of the impact of orientation on thermal comfort. Valuable insights can be gained through this study, into the dynamics of indoor thermal comfort and its potential implications for affordable housing design.

## Methodology

The methodology for this research involved a multi-step approach. Firstly, suitable housing schemes in the western province were identified through a survey, considering factors such as climate and contextual surroundings. Data gathering focused on different apartment orientations and heights within the selected housing schemes, with an emphasis on understanding how surrounding factors like vegetation and neighbouring buildings influenced shade and wind patterns. A questionnaire was designed and administered to collect data on occupants' perceptions of thermal comfort, covering aspects such as comfort during the day and night, ventilation preferences, and methods used to control thermal comfort. The collected data were then compared to assess indoor thermal comfort levels, considering factors like orientation, height, ventilation, and shade. The findings were summarized and discussed, highlighting the relationships between these factors. This methodology provides valuable insights into the complexities of indoor thermal comfort and contributes to the ongoing discourse on housing design considerations in relation to occupant comfort.

## Results and Discussion

The study collected questionnaire responses from 46 units of the condominium housing scheme. Results showed that out of the 46 responses, only a small number of apartments reported being thermally comfortable during the day and night. Additionally, perceived thermal levels at night were generally lower compared to daytime levels, as expected. Notably, the building on the northwest-southeast axis had the lowest thermal discomfort levels, while the building on the northeast-southwest axis had the highest.

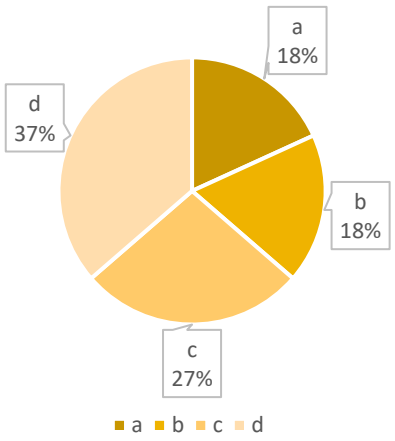


*Figure 2: Responses recorded as thermally comfortable during the day sorted by orientation.*

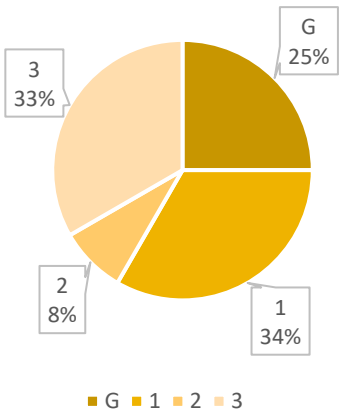


*Figure 3: Responses recorded as thermally comfortable during the day sorted by floor height.*

Ground floor and first floor apartments generally had lower thermal comfort compared to higher floors. 26 apartments reported that they receive adequate natural ventilation, and 15 apartments reported that they received adequate shade. Most residents used fans for thermal comfort control, with a few using air conditioning. Overall, the results showed almost similar patterns across the buildings, with minor variations observed. These findings emphasize the importance of considering factors such as orientation, floor height, ventilation, shade, and active thermal comfort control in condominium housing design to enhance occupants' satisfaction.

## Conclusion

In conclusion, this study investigated indoor thermal comfort in condominium housing, considering factors such as orientation, floor height, ventilation, and shade. Out of the 46 apartments surveyed, only 11 reported being thermally comfortable during the day, and 13 at night. Surprisingly, the building with a north-south orientation, typically considered less favourable, had the highest number of responses indicating thermal comfort during the day, potentially due to shade and natural ventilation. The ground floor and first floor showed more comfortable thermal comfort levels compared to higher floors, likely due to shade and protection from the roof. Residents' perception of thermal comfort varied, with individuals having different preferences and adapting to change clothing and activity patterns. Through these findings we can suggest several design solutions to enhance occupant satisfaction and energy efficiency. These solutions include incorporating effective shading devices, optimizing building orientation for natural ventilation, using high-performance insulation materials, integrating smart building systems, and educating residents about energy-efficient practices. By implementing these solutions, architects and developers can create condominium housing schemes that prioritize thermal comfort, reduce energy consumption, and provide affordable and sustainable living environments for residents.

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# IMPACT OF BUILT ENVIRONMENT TO ACHIEVE SOCIAL SATISFACTION IN POST-DISASTER HOUSING RESETTLEMENTS

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## Introduction

Many people in different parts of the world are displaced and relocated due to different types of disasters caused each year. Those disasters take thousands of lives and cause unexpected economic crises, environmental losses, property damages and complicated social issues predominantly in developing countries. Among those natural disasters, landslides are known to be one of the most hazardous disasters which is frequently occurring in the hill country, Sri Lanka. Hence, planning of post disaster resettlements is one of the crucial needs when rebuilding the vulnerable communities during disaster resilient programmes conducted by the Sri Lankan government with the help of Non-Government Organizations (NGO's). Even though extensive research has been done on the subject, Sri Lanka's landslide resettlement programme has fallen short of expectations (Vijekumara, 2015). As an example, Maheshika & Sangasumana (2017) explain that resettlement programs did not adequately satisfy the concerns of the impacted population at Meeriyabedda and there were no conclusions that ensure long term satisfaction of victimized rural communities in these resettlements.

As explained by Hidayat & Egbu, (2010), it is impossible to achieve the successful relocation without a well-planned and managed process. Although, SL government has resettled most of the victimized communities, many social researchers have highlighted that needs of the communities were not met even after several years of resettlement programmers. There is a gap between resettlement and social connectivity and achieving community satisfaction. These programs were mainly focusing only on 'how to relocate?', rather focusing on the massive impact which can make through the given built environment over long-term satisfaction of a victimized community. Thus, the study aims to investigate the current situation of the selected victimized communities and their social satisfaction over a certain period of time after living within the given built environment. To fulfil the aim of this research, following objectives were proposed such as: to identify the relevant indicators that affect social satisfaction of a community through a comprehensive literature review, to collect the data using selected samples of post disaster resettlements, to analyse the selected data using a mix method and to propose relevant improvements to uplift social satisfaction of selected post disaster resettlements.

## Methodology/experimental design

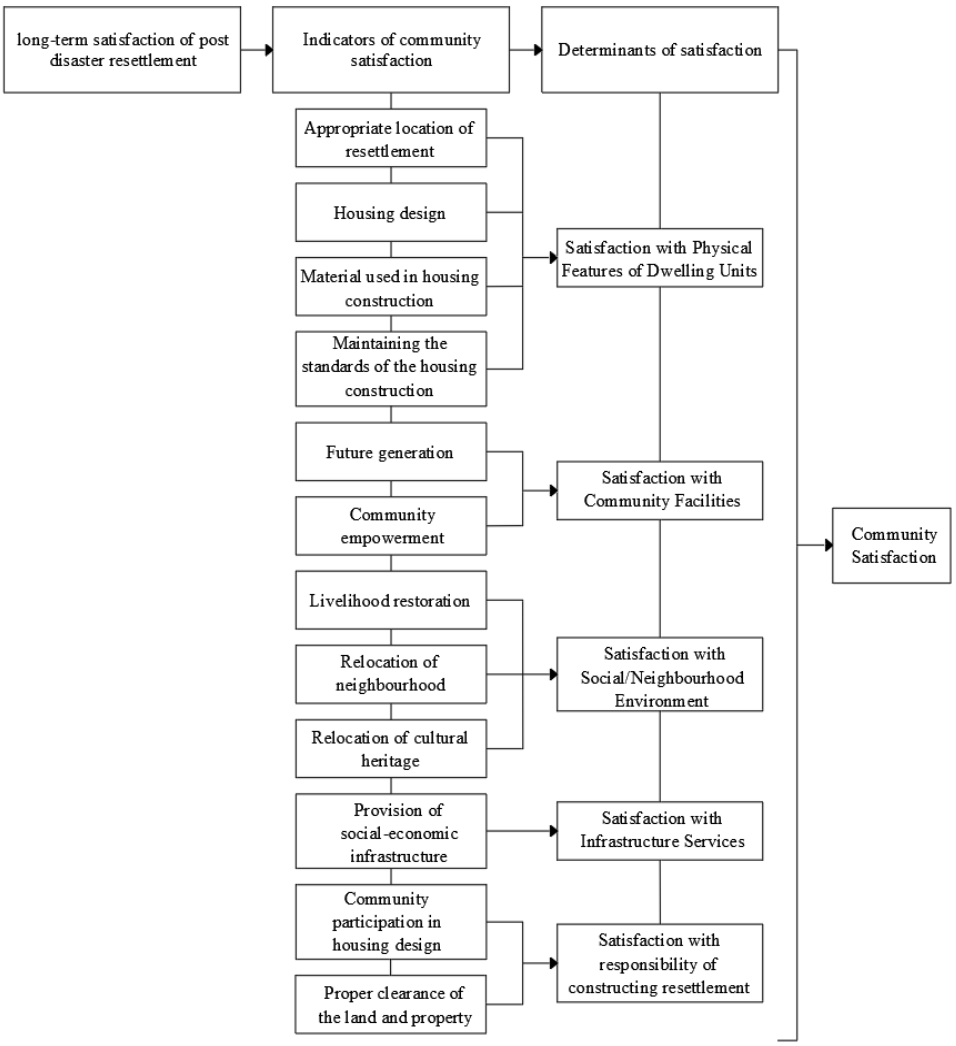


*Figure 1: Determination of community satisfaction*

This study examines and analyses the most important factors affecting the long term-satisfaction in post disaster resettlement programmes. Further, the comprehensive literature study summarizes the list of indicators which impact on long-term social satisfaction in post-disaster resettlement programmes. Three (03) post-disaster resettlements were selected as case studies, which were built during 2015-2017 in rural areas (Meeriyabedda, Aranayaka, and Bulathsinhala). Fifty (50) samples were taken from each case which is more than 75% of the recorded population.

The data were collected using semi-structured interviews and own observations while analysing the architectural layout of the existing resettlements. Mixed methods were used to analyse the collected data by using SPSS software with frequency analysis and Chi square analysis.

## Results and Discussion

The literature summary shows that researchers have identified a list of indicators for community satisfaction in different perspectives. It is concluded that case study one: Koslanda Makaldeniya resettlement, at Meeriyabedda – (2015-2016), is one of the unsatisfied resettlements due to the less infrastructure facilities as well as the lack of studies done to understand the cultural values of estate Tamil people. The people who were selected in case study two: Wasanthagama resettlement at Aranayaka – (2016-2017) can be concluded as partially satisfied resettlement because it fulfills the housing requirement but not the infrastructural and social needs. The case study three: Oshinton waththta resettlement at Bulathsinhala- (2016-2017) can be identified as a satisfied resettlement because the resettlement programme commenced with an owner-driven approach though it was not monitored until the completion by the responsible parties who were involved in the project.

## Conclusion

The study concluded that participatory design approach is one of the prime important aspects to consider in achieving long-term social satisfaction in post-disaster resettlement programmes. In addition, the study proved that the owner-driven approach is considerably more effective than donor-driven approach in designing the settlements where sensitive communities live in rural households. Further, the resettled communities demanded for a more community-friendly, responsive planning programme to uplift their current social conditions. In addition, a list of actions are identified to consider in the beginning of the resettlement programs to achieve the long-term social satisfaction in Sri Lanka such as;

1. Proposing participatory design approaches for resettlement programmes
2. Proposing owner- driven approaches, as it is evidenced to be more successive than the donor-driven approach, restoring income sources and development of social services
3. Proposing well-planned infrastructure services from the initial stages of the design
4. Proposing to give proper training to respond on early warning systems to vulnerable communities and awareness of future hazards with the help of relevant authorities.

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# PROPOSE SUGGESTIONS TO IMPLEMENT BLOCKCHAIN TECHNOLOGY TO IMPROVE THE PRODUCTIVITY OF SRI LANKAN CONSTRUCTION INDUSTRY

GPDA Weerarathna[#] and KPSPK Bandara

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## Introduction

National economic growth relies heavily on the construction industry. As a result, many jobs and income are created for overall society by the infrastructure provided by it. In the construction industry, numerous disputes and litigation problems have arisen about payments withheld, quality fraud, and data authentication. Researchers and practitioners have recognized that construction project business processes lack transparency and accountability (Rebecca Yang a, 2020). Supply chain developments in the construction industry are being handicapped by a drop in mean value and a rise in transactions. In construction supply chains, low trust has been an ongoing problem for a long time, because of decentralized teamwork. Through digital technology, it may be possible to achieve the criteria of centralized teamwork with high transparency. It is the primary purpose of these technologies to increase trust, visibility, and traceability as well as strengthen partnerships among key stakeholders regarding the sustainability of the materials (Yang et al., 2020). Many applications of this technology have been proposed and discovered recently in the construction industry (Khawar Ahmed Khan, 2021).Proposing suggestions to implement blockchain in the Sri Lankan construction industry and improving its productivity are the main objectives of this thesis.

## Methodology

The main research philosophy for this research is mainly positivism, which is based on the opinions of the people (professionals). To accomplish the study's goals, primary data were gathered thorough a questionnaire survey and semi-structured interviews. A preliminary questionnaire was conducted to obtain data for preparing the expert interviews and a preliminary interview was conducted to obtain data for the preparation of the questionnaire. Preliminary questionnaire and the main questionnaire were prepared with including the structured and unstructured questions. questionnaire was developed and distributed among the professionals in the constructions industry and familiar with blockchain technology. The preliminary interview and the expert interview were conducted by using purposive sampling who are experts in the construction industry and familiar with both the Sri Lankan construction industry and blockchain technology.

The preliminary questionnaire was distributed for collecting further data vague. The preliminary interviews were conducted prior to preparing the main questionnaire. The expert interview was conducted with ten experts and the questionnaire was responded by 35 persons.

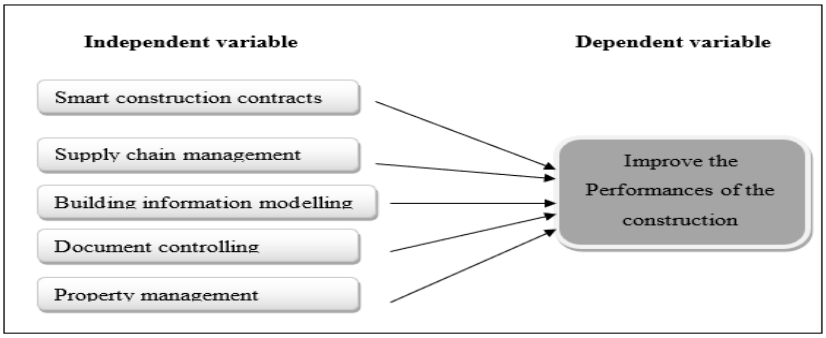


*Figure 1: Conceptual Framework*

## Results and Discussion

According to the literature survey, ten key performance factors (KPIs) Time, Cost, Quality, Safety & Health, Internal Stakeholders, External Stakeholders, Client Satisfaction, Financial Performance, Environment, and Information, Technology & Innovation (E Soewin1, 2017) were used for this study, and they were used in preparing a preliminary questionnaire survey to examine the order of importance. Likert scale accordance with the importance was used for that purpose.

### *A. Correlation analysis*

The results of correlation analysis were shown that there are relationships between the independent and dependent variables.

**Correlations**

| | | ASCC | ASCM | ABBM | ADCM | ABPM | AABC |
|---|---|---|---|---|---|---|---|
| ASCC | Pearson Correlation | 1 | .757** | .657** | .614** | .474** | .509** |
| | Sig. (2-tailed) | | <.001 | <.001 | <.001 | .004 | .002 |
| | N | 35 | 35 | 35 | 35 | 35 | 35 |
| ASCM | Pearson Correlation | .757** | 1 | .510** | .475** | .484** | .613** |
| | Sig. (2-tailed) | <.001 | | .002 | .004 | .003 | <.001 |
| | N | 35 | 35 | 35 | 35 | 35 | 35 |
| ABBM | Pearson Correlation | .657** | .510** | 1 | .606** | .424* | .673** |
| | Sig. (2-tailed) | <.001 | .002 | | <.001 | .011 | <.001 |
| | N | 35 | 35 | 35 | 35 | 35 | 35 |
| ADCM | Pearson Correlation | .614** | .475** | .606** | 1 | .636** | .586** |
| | Sig. (2-tailed) | <.001 | .004 | <.001 | | <.001 | <.001 |
| | N | 35 | 35 | 35 | 35 | 35 | 35 |
| ABPM | Pearson Correlation | .474** | .484** | .424* | .636** | 1 | .451** |
| | Sig. (2-tailed) | .004 | .003 | .011 | <.001 | | .007 |
| | N | 35 | 35 | 35 | 35 | 35 | 35 |
| AABC | Pearson Correlation | .509** | .613** | .673** | .586** | .451** | 1 |
| | Sig. (2-tailed) | .002 | <.001 | <.001 | <.001 | .007 | |
| | N | 35 | 35 | 35 | 35 | 35 | 35 |

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

*Figure 2: Results from correlation analysis (SPSS)*

## *B. Regression analysis*

| Coefficients | | | | | | |
|---|---|---|---|---|---|---|
| Model | | Unstandardized Coefficients B | Unstandardized Coefficients Std. Error | Standardized Coefficients Beta | t | Sig. |
| 1 | (Constant) | .030 | .682 | | .044 | .965 |
| | ASCC | .375 | .214 | .367 | 1.752 | .090 |
| | ASCM | .603 | .213 | .514 | 2.828 | .008 |
| | ABBM | .536 | .178 | .489 | 3.007 | .005 |
| | ADCM | .279 | .181 | .273 | 1.543 | .134 |
| | ABPM | .005 | .176 | .004 | .026 | .980 |
| a. Dependent Variable: AABC | | | | | | |

*Figure 3: Results of regression analysis (SPSS)*

As per the results, the construction industry improves its performance by 37.5% by implementing BCT in smart construction contracts, 60.3% in supply chain management, by 53.6% in BIM, by 27.9% in document management and 0.5% by implementing BCT in property management.

## *C. Content analysis*

According to the experts, all the performance indicators of the construction industry can be improved with adopting to the blockchain technology. Other than the KPI's, as 'Trust and Transparency' are also mentioned throughout the Project Management Body of Knowledge (PMBOK) as significant aspects to be followed, the management process in the construction sector is also can be improved with adaptation to blockchain technology. there are very few blockchain applications used in construction industry. However, there are many proof-of-concept projects, or prototype systems being developed.

Sri Lanka is not in an appropriate level to adopt blockchain technology. Resistance to change could be a big barrier too. BCT is not only for use by one single company. It's a more ecosystem. The knowledge gap and the lack of capability of technical feasibility & the initial cost of implementing are the barriers that can be found in Sri Lanka that effect the implementation of Blockchain technology. If there's a need to use IT professionals to do some jobs, it is preferred to go for joint ventures or collaborations with companies. When integrating with another company, could be a saving. parties could give the knowledge and in return, construction professionals could share construction knowledge as a construction company. And the IT company can develop the system.

After the above suggestions are fulfilled, the experts recommend starting to apply blockchain for payment handling system. The respondents mentioned that after a payment handling system is adopted, then quality tracking in the supply chain can be followed. BCT can be used to track the certification of raw materials and intermediate products. In this way, it can solve supply chain management problems very well. One respondent said further about the areas that can adopt BCT as document management. Trust in the documents, maintenance, facility management, and asset management are the prominent areas in the Sri Lankan construction industry which can use BCT for future implementations.

## Conclusion

From the 1st objective, the performance indicators that affect the improvement of the construction industry were identified through secondary data analysis. And ranked through RII analysis method. The 2ndobjective gives a connection to the main two areas that are discussed in the study. Data for this objective was obtained through secondary data and preliminary interviews. Preliminary interviews were gained by four experts in the industry who are familiar with blockchain technology. This objective provides outputs mainly on how blockchain differs from other technologies and what the characteristics of BCT benefit the construction industry. Some visible and research-level blockchain applications were identified through the data collection that is possible to apply in the construction industry. The collected data were analyzed using content analysis.

For the 3rd & 4th objectives, a detailed questionnaire was distributed among construction industry professionals familiar with digitalization technologies and blockchain. SPSS software was used to analyze the collected data. Through that analysis, it was proved that there is a relationship and impact between variables. For both objectives, an expert interview was also conducted. Data was collected by ten experts in the industry who are familiar with BCT. The main outcomes that were obtained are, identifying the characteristics of BCT that will benefit to improve the KPIs with the performances of the construction industry and About the BCT applications that are used in the world in construction.

For the 5th objective, the data collection was fully based on expert interviews. It was analyzed completely through content analysis. The main outcomes that were gained by the expert interviews are, the reasons for not using blockchain in Sri Lanka's construction industry, the readiness of Sri Lanka to adopt BCT, the barriers to implementing BCT in the Sri Lankan construction industry & suggestions and recommendations of professionals on what solutions can be put into practice by the Sri Lankan construction industry to implement BCT.

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# IMPACT OF QUANTITY SURVEYING PRACTICES TOWARDS CONSTRUCTION INSOLVENCY STIMULUSES FOR SRI LANKAN CONTRACTORS

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## Introduction

When an organization encounters issues in finance and fails to pay off the debts to a company or a person, it is referred to as suffering from insolvency. According to Census Bureau data from 2012 to 2022, construction companies are 1.5 times likely to become a victim of bankruptcy compared to other industries. The rate of failure in construction businesses according to Scott Shane's 2013 data compilation of Business dynamic statistics does demonstrate that construction companies do have a 65% chance of failing during their first five years. Quantity surveyors as a profession has evolved over the years over areas related to Law, Management, Finance, Valuation to name a few. The Pathway guide Quantity Surveying and Construction suggests Quantity Surveyors should be competent in "Corporate Recovery and Insolvency" and have a thorough understanding in how the insolvency has affected their project and the legal and contractual position of the parties involved. This research study aims at investigating the Quantity Surveying practices being imposed within a project to avoid or mitigate the risks beforehand facing insolvency and going bankrupt through managing and implementing skills and experiences in insolvency matters since the Quantity Surveying practices could directly affect insolvency where the criticalness of these causes within industry could be often neglected or unknown (Ooghe and de Sofie, 2008; Lukason and Hoffman, 2014).

## Methodology

### *A. Data Collection Methods*

Both Questionnaire surveys, and semi-structured interviews were conducted to collect the primary data intended for further analysis parallel to 12 construction insolvency stimuluses. As for the secondary data, a comprehensive literature survey was carried out. The Questionnaires were both handed out via electronic and physical means while the interviews did take place through telephonic conversations and in face-to-face approach.

## *B. Data Analysis Methods*

*1. Relative Importance Index (RII)*

Through the implementation of the RII, identified causes were compatible to rank them in order indicating which cause did matter the most in both regards. RII calculates the Primary data with an output between 0 and 1. (Rajgor et al., 2016) The higher RII value suggested a relatively important cause compared to others. The RII or the Relative Importance Index was used at two different instances.

*2. Standard Deviation and Mean*

Standard Deviation can be denoted as the degree of dispersion of the data relative to its mean value. Standard Deviation offers an understanding of how the data gathered are spread across the data sample (Hussain et al., 2017).

# Results and Discussion

## *A. Ranking according to RII values, Standard Deviation and Mean*

*1. According to the Severity factor*

According to the analyzed data, inaccurate estimating is ranked higher than the rest of other causes with almost a similar RII value in poor cashflow management as well. This may denote a similarity between these two indicating, that without estimating properly, it would be useless and harder to manage the cashflow and the poor cashflow management could ruin properly carried out estimations completely. Another apparent reason especially within the year 2022 was the labor and material shortage. The collective agreeing nature of the respondents towards this factor is further denoted by the least standard deviation value for SR8 factor.

*2. According to the Quantity Surveyor's intervention*

Managing the cashflow has the highest RII2 value with a mean value over 3.9, denotes that it is the factor which has the highest contribution of a Quantity Surveyor. Upon the fact of having a lower standard deviation and a higher mean, estimating practices was ranked the 2nd whereas, Estimation is a core competency a Quantity Surveyor should be able to perform on. Fluctuations in material costs was ranked the 3rd factor a Quantity Surveyor's intervention is necessary. Though the Fluctuations themselves are out of control, the Quantity Surveyor has a significant responsibility in claiming for material fluctuations.

## *B. Absolute difference and the Overall RII*

Absolute difference was calculated and the Overall RII values were ranked again, so that each potential Insolvency/ Bankruptcy cause could be able to understand without a bias (Severity or Quantity Surveyor's Intervention). These values indicate an idea of whether the effort taken to avoid mitigate the risk of insolvency is worth it or not rather than ranking both RII1 and RII2 alone. But these ranks do not indicate the overall impact taking the Severity factor and the Quantity Surveyor's contribution.

## Conclusion

The Quantity Surveyor does have limitations within their practice and should know how such a profession could have an overall impact. Comparing both RII1 and RII2 value rankings does implicate the connections between the above. Several factors had a low possibility of remedying the same factors with a lower RII2 value. It should also be noted that factors with a higher absolute difference value also denoted the factors which are either less severe or had less contribution from Quantity Surveying practices. Therefore, a Quantity Surveyor should put the effort into these 12 causes taking both the Severity factor and the intervention factor in an overall sense. With the data gathered, it became more evident that there are several areas Quantity Surveyors do not usually practice in, but still are viable to perform in. Project management practices could greatly help the project in finance and technologies such as BIM and other management software packages could also make the project to perform efficiently and effectively.

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# GEOSPATIAL ANALYSIS OF TEMPERATURE FLUCTUATIONS DUE TO THE RAPID PHYSICAL DEVELOPMENT IN THE GREATER HAMBANTOTA PROJECT

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## Introduction

The Greater Hambantota project is a large development project in Sri Lanka. The major goal of this new super city plan is to make it the second-biggest regional and urban development centre or just to work as a deterrent to Colombo and, as a result, decentralize economic growth in Sri Lanka. The town's profitable location to be developed for a prosperous city centred on the port of Hambantota is vital for international interconnections due to its efficiency and the benefit of the 25-kilometre quick journey between the harbour and Mattala Airport.

Those development plans were implemented within a short time and it causes changes mainly through reductions of green areas, an increase of manmade features like buildings, and even changing the land use in some areas. Such factors affect temperature fluctuations. Through this research, a study is conducted on the temperature variation due to the rapid development of the Greater Hambantota project. Remote sensing (RS) technology integrated with the Geographic Information System (GIS) system was used to conduct this study (Yue et al., 2013).

## Methodology

Environmental parameters can be collected, investigated, and modelled using thermal infrared (TIR) remote sensing. It enables one to determine the land surface temperature (LST). This study used Landsat satellite images considering pre-development, during-development, and post-development phases. Different pre-processing techniques were used for this analysis.

*Table 1: Satellite images used for the analysis*

| Satellite series | Year | Date Acquired | Weather |
|---|---|---|---|
| Landsat_5 | 2004 | 27.02.2004 | Sunny |
| Landsat_8 | 2017 | 13.01.2017 | Sunny |
| Landsat_9 | 2022 | 04.02.2022 | Sunny |

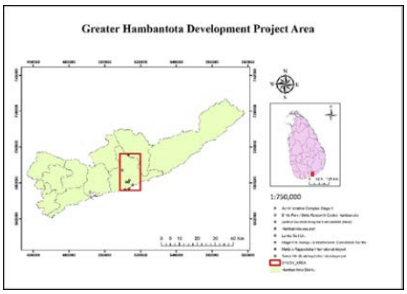


*Figure 1: Study area*

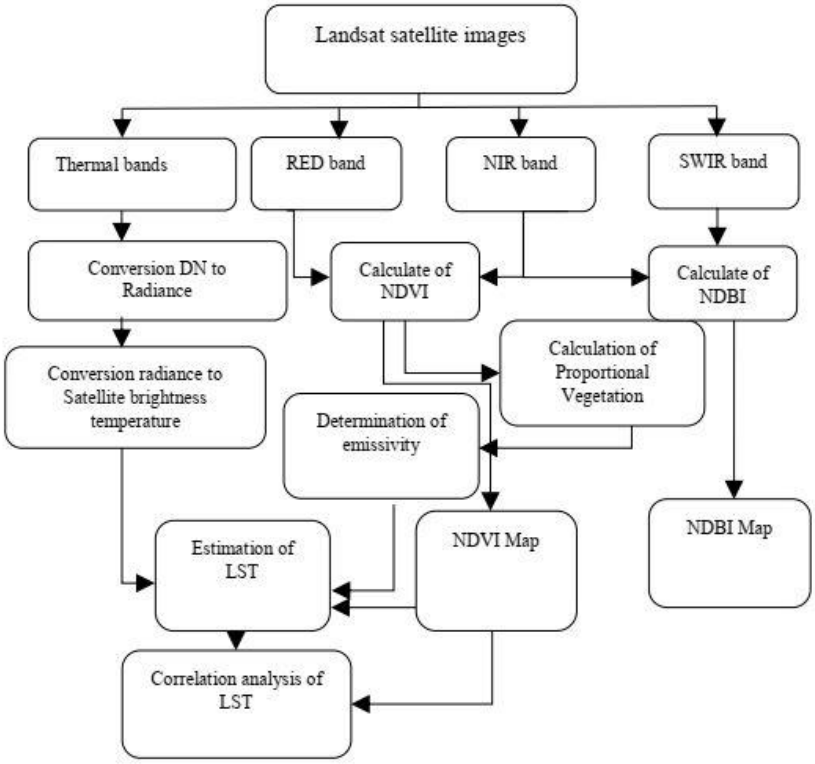


*Figure 2: Experimental workflow*

## Results and Discussion

The findings addressed the study's objectives and analysed how the Arc GIS program was used to achieve results. It specifically addresses the temperature variations with the development processes conducted in each period. In addition, derived the relationships of temperature fluctuations with NDVI and NDBI.

### *A. LST analysis*

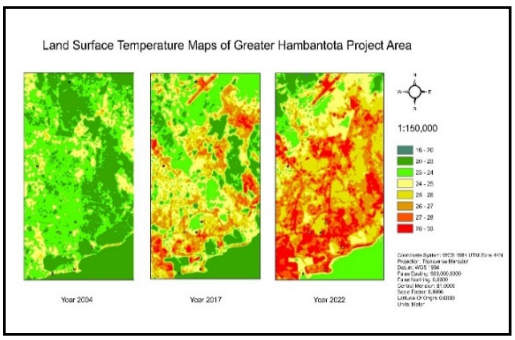


*Figure 3: LST map*

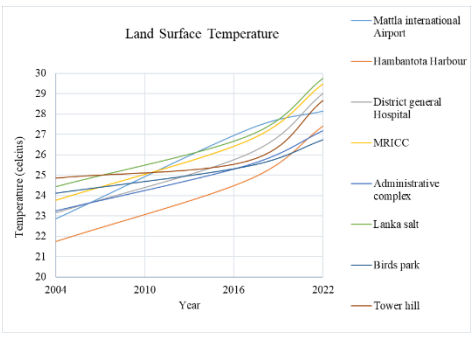


*Figure 4: LST variation at project locations*

When considering LST 2004, the highest area corresponds to the temperature range of 23-24, and in 2022, it moves toward to 25-26 range.
It reveals that land surface temperature gradually increased with the development activities.

## *B. NDVI analysis*

Diverse NDVI variations were shown at the Mattala international airport project and NDVI value gradually decreased with time at all the project areas. When comparing the LULC changes in the Greater Hambantota development project area it illustrates that development processes mostly affected the reduction of sparse vegetation areas and shrub and grasslands. In addition, it demonstrated the increment in water areas due to the development of Hambantota Harbour (Deardorff, 1978).

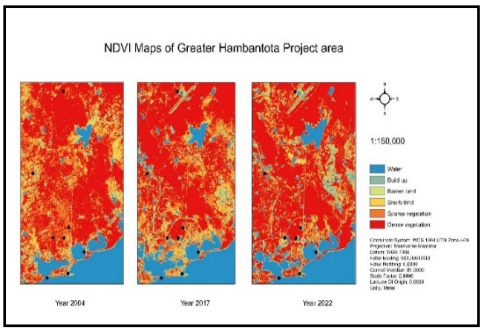


*Figure 5: NDVI map*

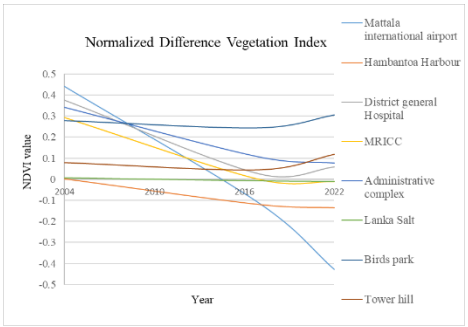


*Figure 6: NDVI variation at project locations*

## *C. NDBI analysis*

Diverse NDBI variations were shown at the Mattala international airport project and NDVI value gradually increased with time at all the project locations.

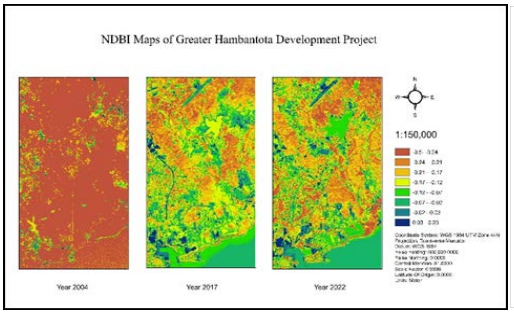


*Figure 7: NDBI map*

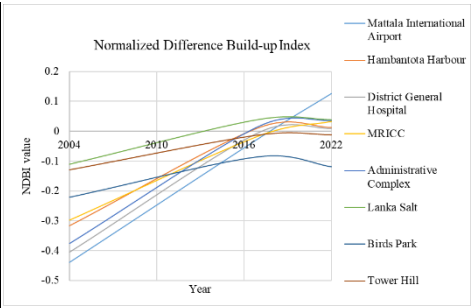


*Figure 8: NDBI variation at project locations*

According to values given by NDVI and NDBI calculations it was considered the temperature changes at the determined project locations with the LULC changes. As a final point, it was determined temperature fluctuation and correlations with LST with NDBI and NDVI value.

### *D. Correlation analysis*

*Table 2: Pearson product correlation coefficients*

| | 2004 | 2017 | 2022 |
|---|---|---|---|
| NDVI & LST | -0.15448 | -0.30076 | -0.18993 |
| NDBI & LST | 0.737439 | 0.127401 | 0.396544 |

The study demonstrates a positive correlation between LST and NDBI values and a negative correlation between NDVI and LST values. In summary, it can define that the reduction of NDVI values causes an increase in surface temperature. In addition, a positive correlation between LST and NDBI values means that it causes to increase in land surface temperature.

## Conclusion

LST has a significant negative association with the NDVI, which is -0.15 in 2004 and -0.19 in 2022, and a largely positive relationship with the NDBI, which is 0.74 in 2004 and 0.40 in 2022. According to these values, it can be identified that an increase in NDVI values means the growth of vegetated areas caused to the reduction in the LST. Furthermore, an increase in build-up areas caused to rise in LST due to the raw materials and a decrease in green areas.

As an overall outcome, it depicted development processes and changes in LULC patterns' effects on the gradual increment of LST. As the LULC varied with the development, there may be a change in the land surface temperature also. Steel, concrete, tar, iron, chemicals, and other artificial substances are added to the environment. Then the heat radiation pattern can change according to the materials. With these constructions, the land surface temperature can be increased by a few more degrees. In addition, it reveals that NDVI values increased in the post-development phase caused the species' beginning of the reproductive period and ability to produce fruit or grain when exposed to temperature extremes (Hatfield and Prueger, 2015).

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# GEOSPATIAL ANALYSIS OF URBAN GROUNDWATER QUALITY BY UTILIZING GIS - A CASE STUDY IN GAMPAHA DISTRICT SRI LANKA

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## Introduction

In Sri Lanka, the need for groundwater is always growing, particularly for irrigated agriculture, the industrial sector, and urban/rural water supplies. According to information from the National Water Supply and Drainage Board (NWSDB), Sri Lanka has 30,000 deep groundwater wells. Shallow karstic aquifers, lateritic aquifers, shallow regolith aquifers, deep confined aquifers, alluvial aquifers, and coastal sand aquifers are just a few of the six main types of aquifers that Sri Lanka has identified. In addition to these aquifers, many groundwater pockets can be found in Sri Lanka. Groundwater in Sri Lanka is about 8 $km^3$ (IGES Freshwater Management Project, 2007). Development and urbanization directly affect the groundwater quality and agricultural, commercial, residential, industrial, and municipal activities contribute to the deterioration of groundwater quality in urban areas. In urbanized areas due to the increase in population, temperature and garbage can be effective for the quality of groundwater and quality of drinking water. As a result of rapid urbanization, groundwater quality can be changed. Gampaha district is the most populous district in Sri Lanka and it is one of the important cities in our country facing significant urbanization and development.

Therefore, a comprehensive study of groundwater quality for the Gampaha district is significant. But there is still no comprehensive analysis of groundwater quality in the Gampaha district. Therefore, this investigation supports a comprehensive investigation of the quality of groundwater in the Gampaha district that can be used to further analysis. Hence, water resources in the Gampaha district can be used properly way and can get the real picture of the drinking water quality in the Gampaha district. The specific objectives of this study are to identify major factors that affect the groundwater quality in the Gampaha district and map the spatial distribution of those factors. According to these specific objectives the major objective of this study is to map the groundwater quality in the Gampaha district and assess suitability for drinking purposes using GIS.

## Methodology

The type of research is quantitative and secondary data is used for carrying out the study. This study consists of a descriptive approach and by using GIS and

geostatistics techniques groundwater quality map was prepared. For the analysis, ArcMap 10.5 software was used.

Groundwater quality data was obtained from National Water Supply and Drainage Board (NWSDB) and the land administrative boundary of the Gampaha district was obtained from the survey department of Sri Lanka. There were more quality parameters defined by the world health organization such as the potential of Hydrogen (pH), Iron, Electrical Conductivity (EC), Hardness, Nitrate, Sulfate, and Chloride like that (World Health Organization 2004). EC, pH, Iron, Chloride, Sulfate, Hardness, and Nitrate are the identified parameters that impact the quality of groundwater in the Gampaha district according to NWSDB and WHO guidelines. WHO standards were used for the analysis of the quality of drinking water in the Gampaha district. Root Mean Square Error (RMSE) calculations were used for accuracy assessment and water quality index calculations were used for weights calculation of the parameters.

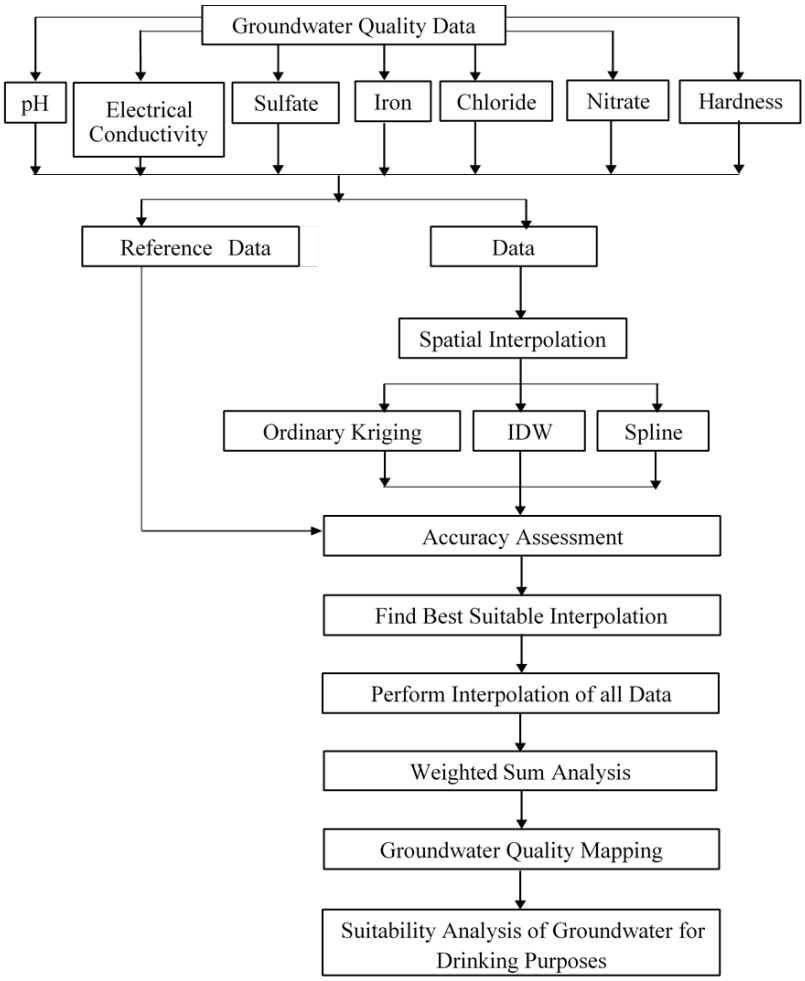


*Figure 1: Experimental Design*

## Results and Discussion

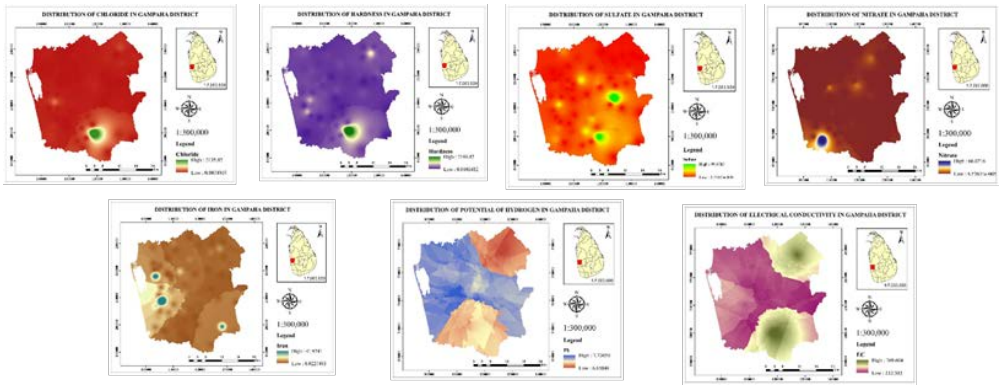

*Figure 2: Spatial Distributions of Quality Parameters*

*Table 1. Area coverage of classified classes*

| Class | Area($km^2$) | Percentage |
|---|---|---|
| Suitable | 68.6175 | 5% |
| Moderate Suitable | 892.78 | 65% |
| Highly Suitable | 420.7425 | 30% |

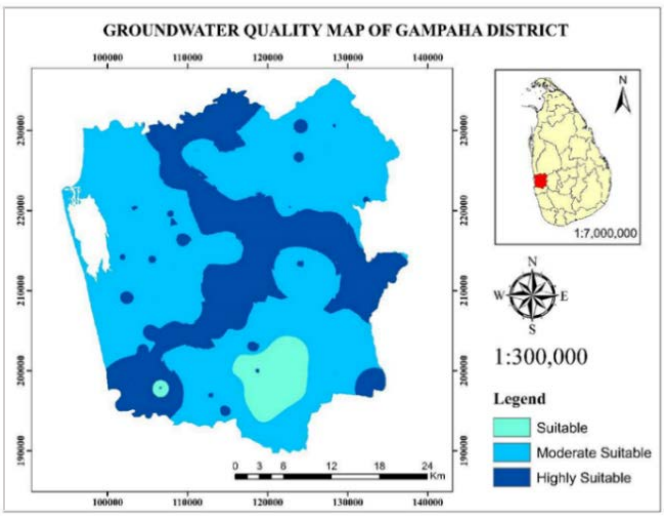


*Figure 3: Groundwater Quality Map*

According to the final output, the quality of groundwater was good in the Gampaha district and the water quality of the whole area in the district was appropriate for drinking purposes. Therefore, haven't polluted groundwater in the Gampaha district according to WHO guidelines. The result of the final groundwater quality map is categorized into three classes such as suitable, moderately suitable, and highly suitable using WHO guidelines for drinking water quality. Table 1 shows the area coverage of each class. As a result of the analysis, most of the areas were moderately suitable for drinking purposes a percentage of sixty-five. Thirty per cent of the area was highly suitable for drinking purposes and five per cent of the area was suitable for drinking purposes.

According to this study, the urbanization and development of the Gampaha district have not affected the quality of groundwater. Therefore, the Quality of groundwater has not changed due to industrial, agricultural, commercial, and residential activities. And also, all the groundwater in the whole area is suitable for drinking purposes. Therefore, all the people in the Gampaha district can be used groundwater for drinking, agriculture, and other purposes.

## Conclusion

Groundwater quality mapping is significant for Sri Lanka because most of the people in the Gampaha district use groundwater for their work, especially for drinking purposes. Therefore, the quality of water is significant. The Gampaha district is one of the greatest urbanized and populous districts in the country. Therefore, the main objective of this study was to map the quality of groundwater in the Gampaha district using GIS and geostatistical techniques to generate a clear picture of the current context. GIS is the best tool for mapping, querying, and analysing.

This study shows all the people in the district still can use groundwater for drinking purposes. Hence should be avoided unnecessary use of water in tap lines and try to use groundwater for day-to-day life useful. From that can reduce purification expenditures and can use the natural resources in the country effectively. It may be helpful for the development of the country and economy.

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WHO, 2004. *Sulfate in Drinking-water Background document for development of WHO Guidelines for Drinking-water Quality*. Available at http://www.who.int/water_sanitation_health/dwq/chemicals/sulfate.pdf (December 2015).

# IMPACT OF BUILT FORMS IN UPLIFTING THE MENTAL HEALTH OF PEDIATRIC CANCER PATIENTS

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## Introduction

With non-communicable diseases on the rise, data from the World Health Organization (2018) reveals that more than 14 million people around the world suffer from the threat of cancer, with nearly 8 million patients experiencing death. The effects of cancer and its related treatment techniques greatly impact on a patient's mental and emotional wellbeing in addition to its physical impact. Although early detection, care and effective healthcare facilities can lead to recovery, the nature of the sterile and isolated nature of such modern facilities often lack the warmth and human feeling that many patients require for better emotional wellbeing, due to the utilitarian and efficient nature of cancer centres and hospitals. The concept of creating 'healing spaces' using architecture aims to address such challenges by creating and designing medical institutions that are more comfortable for the patient, taking a step away from the uncomfortable and sterile feel of modern-day healthcare facilities that could create an additional stress to the patient's psyche. This publication will address the noticeable lack of up-to-date, systematically reviewed research, specifically focusing on the existing literature on paediatric cancer patients and the impact on their healing factors caused by architectural design, and as a result, assists in presenting a clearer understanding of the connection between architecture and its impact on the healing process in human psychology.

## Methodology

This research was conducted by focusing solely on child-cancer patients and surveying existing literature on the subject. Researches, journal articles and publications on healing architecture, cancer treatments, cancer healthcare centres and paediatric hospital environments were considered in this process. Out of the 30 studies selected for this process, 9 were systematic literature reviews previously published on the subject, considering literature between the period of 1997 to 2021.

All the collected data were subjected to content analysis and subsequently a discussion. Utilizing the PICO (Population, Intervention, Comparison and Outcomes) framework, the said studies were sources from three databases; Scopus, Web of Science and Google Scholar using multiple search methods, including 'snowballing searches,' utilizing many search filters to identify keywords such as paediatric, cancer care, and healing architecture among others to discover the above researches. Only articles and papers written in English were considered for this research.

## Results and Discussion

The literature analysed revealed many factors that affected the senses and experiences of paediatric patients, especially those suffering from cancer. Common design elements and themes utilized to evoke healing and human warmth were identified in the process and synthesized. Healing concepts identified by researchers included the likes of employing positive distractions, colours, healing gardens and aromatherapy to evoke a positive and healing response from paediatric patients with effective results. Employed design strategies include the intelligent use of building orientation and room configuration to create a soothing and natural ambient environment. Factors such as lighting, temperature, ventilation, smell, and natural lighting also had a powerful effect. This research additionally discovered the correlation of these elements and their impact on psychological and social aspects of paediatric patients. This includes their sense of control, feeling of belongingness, personal space, safety and security, space for visiting family and recreational activity, all which considered and implemented in architectural design and have evoked a positive response in the healing of patients.

## Conclusion

In conclusion, this research identifies that research conducted in the past have clearly identified a correlation between the mental, spiritual and emotional wellbeing of paediatric patients, cancer patients particularly and the use of human design elements in architectural design.

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# AN EXPERIMENTAL STUDY TO REUSE FABRIC WASTE AS ALTERNATIVE PARTITIONING MATERIAL IN BUILDING INTERIORS

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## Introduction

The construction sector is a significant contributor to the global material consumption and environmental degradation. In response to fulfilling these demands of the construction industry, researchers have adopted the practices of repurposing waste materials to create novel construction materials (Sizirici, Fseha, Cho, Yildiz, & Byon, 2021). Among these alternative approaches, there are a few researches tried to utilize different textile waste as construction materials in the world. Further, it is important to mention that Sri Lankan garment sector generate loads of textile waste and discharge those to landfills, lead to create massive environmental issues though it contributes on 50% of the gross domestic products of the country (Arachchige, Vithanage, Wadanambi, Wandana, Wijerathne, & Wimalarathne, 2019). Most importantly, it was noticed that there is no established textile waste management system in Sri Lanka, though the factories dump significant amount of waste to the environment. University of Leeds (2020) recorded that only 1% of textile waste can be recycled. Further, 60% of textile waste is plastics, which makes the global fashion industry the second most polluter after the global oil industry. Hence, this study was aimed to investigate the possible methods of reusing the textile waste into a substitute construction material and fulfill the demands in construction industry. This research is predominantly focused on non-load bearing partitioning materials which is developed through fabric waste and three types of adhesives namely PVA, binder glue, and cashew glue prepared domestically.

## Experimental Design

This research experiments on how waste fabrics can be used to create non-load bearing partitions. The literature review covered alternative building materials, Sri Lanka's textile industry, and the properties of common partitioning materials. The study comprises of two distinct phases.

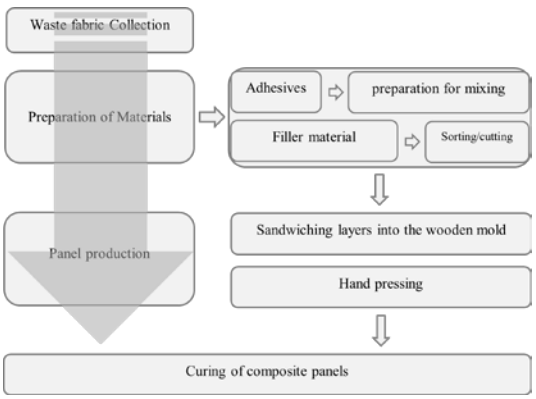


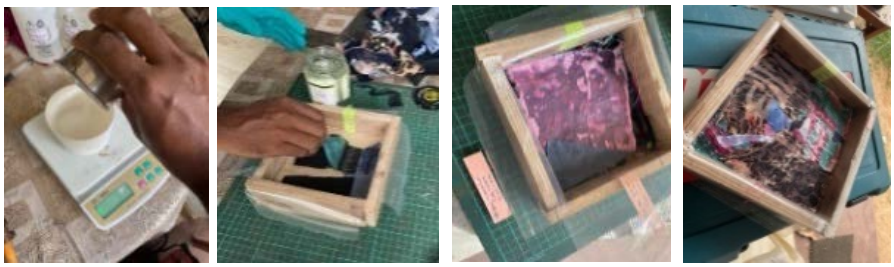

*Figure 1: Process of making composites.*

The first phase of this study involves the production of a diverse range of composite specimens by utilizing discarded textiles and various bonding agents.

The design of adhesives prioritizes accessibility, natural composition, and environmental sustainability. The garment factories facilitated convenient availability of surplus fabrics, while a variety of toolkits were fashioned in-house. The framework utilized for generating samples is illustrated in Figure 1. The unit size served as the primary focus of attention. The dimensions of 150 mm x 150 mm x 10 mm (W x L x H) were well-suited to accommodate both the fabric classification of the pieces and the project scope. Upon completion of the requisite adhesive and filler materials, the procedure was executed in accordance with the guidelines as shown in Figure 1. Table 1 displays the utilized quantities, which were subsequently subjected to dryed for the purpose of testing. Figure 2 shows the stage by stage manufacturing process done in the workshop representing the steps strating from 'a' is preparation and measuring adhesives, 'b' & 'c' is the moulding/sandwiching the layers and finally 'd' is the drying process.

*Table 1 : Adhesive to filler ratio*

| Adhesive | Adhesive To filler ratio | |
|---|---|---|
| | Adhesive+ H20 (g) | filler(s) |
| PVA | 110 | 100 |
| Cashew gum | 230 | 100 |
| Binder | 115 | 100 |



a. b. c. d.

*Figure 2: Manufacturing process*

## Results and Discussion

The specimens mentioned in the study display a common pattern, although with noticeable differences as shown in the figure 3. The results indicate that the adhesive characteristics of cashew glue and binder-based panels and specimens follow a similar trend, while PVA-based panels exhibit a distinct behavior. When comparing these samples based on their maximum tensile strength and elongation, cashew glue-based samples fare better.

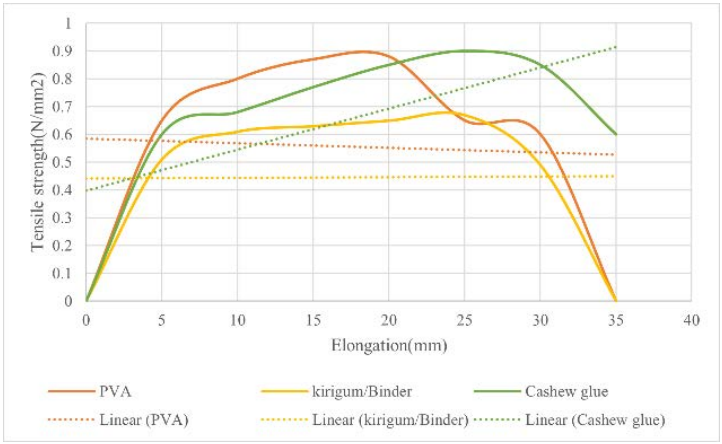



*Figure 3: Overview of measured values of test*

The elastic deformation of each material was nearly identical, and the measured elongation was 5mm. Although elastic deformation of each sample is identical, the plastic deformation is variable, indicating that the fraction points of these samples vary. In terms of the overall behavior of the samples, the sample containing cashew glue performed well. In the sound absorption test results are summarized in the figure 4 and the collected data show that the smallest difference observed was 6.6 dB. The tested samples were demonstrated an absorption of 9.5 dB, while the highest absorption of all samples was 35.8 dB.

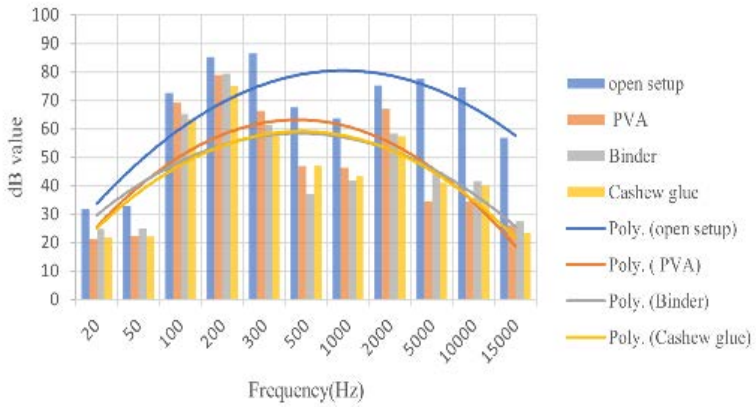



*Figure 4: Trend comparison on all three*

Figure 5 shows sectional cut of a sample and its layers. Man-made fabrics had gaps, but natural fibers like cotton, wool, linen, and others were perfectly bonded. Hence, synthetic fabrics weakens the bonds between layers of the composite material and makes testing more likely.

*Figure 5: Red circled area shows the gaps between layers.*

## Conclusion

The study involved the utilization of adhesives, such as PVA, binder, and a self-made adhesive derived from cashew. The aim of the study was to create a readily available partition panel and economical natural materials derived from waste. The most optimal adhesive option was discovered to be homemade glue on account of its cost-effectiveness and efficacy. PVA adhesive demonstrated favorable adhesive characteristics when used with textiles. Diverse fabric types demonstrated distinct characteristics and results; whereby natural fabrics demonstrated superior adhesive bonding. The non-load-bearing partition wall materials underwent limited testing, with only tensile and sound tests being conducted due to temporal constraints. The tensile test results revealed that the cashew glue-based sample performed the best among the tested samples. Nevertheless, there is room for improvement in future works. In terms of sound absorption coefficient, the samples performed similarly to commonly used construction materials like plywood and plasterboard. The samples demonstrated an average sound absorption of 9.2dB indoors, outperforming the outdoor sound levels of 50 to 65dB, where the samples achieved a 25dB absorption rate. Comparing all the test results, the cashew-based panel stood out as the most favorable option. It exhibited strong adhesive properties, penetrating the fabrics and outperforming PVA and binder-based samples. Considering the literature, experimental results, the cashew glue-based composite panels proved to be the most effective. However, it is important to note that this experiment represents only the preliminary stages of research, serving as a starting point for further studies.

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# IDENTIFICATION OF THE MOST SIGNIFICANT CONTRACTORS RELATED CAUSES OF DELAY IN SRI LANKAN CONSTRUCTION INDUSTRY

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## Introduction

In construction, delay is the period that elapses after the completion date specified in the contract and as mutually agreed upon by the contract's parties. One of the most reoccurring issues in the construction sector around the world is delay (Jadhav, 2018). Delays can lead to many negative effects and one delay could result in the emergence of more delays (Muralidhar, 2018). Large rate of delay in project delivery is a major criticism faced by the Sri Lanka's construction sector. Despite the type or size of the construction project, majority of construction projects are prone to delays, and timely completion is typically exceptional (Jayalath, 2010). Cost, time, and quality equally contribute to the project success (Ramalee, 2016). Therefore, project delay directly impacts on project success. Delays may be caused by one or both contracting parties, a third party who is not a party to the contract, or external forces. Contractor is the party who is mostly responsible for construction delays (Farooqui, 2007). Therefore, taking an endeavour on mitigation of contractor related delays can significantly effect on reducing construction delays. Quantity Surveyor is responsible for the cost aspect of a project and delays are a major barrier for Quantity Surveyors to ensure that cost overrun does not take place (Rathnayake, 2022). Therefore, it is obvious that as a Quantity Surveyor, taking an endeavour on mitigating contractor related delays is important to enhance the performance of Quantity Surveyors. Prior to mitigating them it is at upmost important to identify the most significant causes of contractor related causes of delay in Sri Lanka, since it makes it simple to choose what should be addressed first and what should be prioritized.

## Methodology

The entire research was appraised through questionnaire surveys and interviews held among construction industry professionals in Sri Lanka. This was a combination of both qualitative (interviews) and quantitative (questionnaire survey) analysis. At first, 15 contractor related causes of delay were identified by undertaking a literature review.

A detailed questionnaire was circulated across the construction industry professionals who are actively employed in the Sri Lankan construction sector, and they were

chosen by using stratified random sample technique. In section A of the questionnaire respondent's experience on occurrence of contractor related causes of delay was investigated by using a closed-ended question.

In Section B the respondents were asked to rank the 15 causes of delay which were identified through the literature review accordingly to a five-point Likert Scale, while "1" representing "Unimportant" and "5" representing "Very important". A semi structured interview was conducted using open ended questions for further clarification and explanations on contractor related causes of delay in Sri Lanka. The interviewees were chosen by employing the purposive sampling method. The collected data was analysed using Microsoft Excel and Relative Indices (RI) techniques. The frequency index analysis was employed to rank the factors which gathered through literature survey in ascending order of the agreement as the most significant Contractor related causes of delay in Sri Lankan construction industry.

$$\text{Frequency Index (FI)} = \frac{\sum_{i=1}^{5} ai \times fi}{H \times N}$$

Equation 1: Frequency Index (FI)

## Results & Discussion

According to the responds received for the questionnaire survey, more than 90% of respondents had experienced Contractor related delay on construction projects, highlighting it as a severe issue in the construction sector. Below table indicates the results of frequency index analysis.

According to the above table ineffective project planning and scheduling (D03) was ranked in the first place which means it is the most significant contractor related cause of delay in Sri Lanka. Through the conducted interview it was revealed that unavailability of a proper estimate in activity duration and number of resources, inefficient work breakdown structure and ignoring critical tasks are the main reasons for ineffective project planning and scheduling. Poor site management and supervision (D01) ranked as the second most frequent reason for contractor related delay. During the interview one interviewee explained that poor site management includes loss of material on site, damage of material on site, ineffective storing and handling of resources and regular material shifting from one location to another due to the lack of a defined storage area. The third most significant contractor related cause of delay was rework due to errors during construction (D05). One interviewee mentioned that repeating a task that was incorrectly completed the first time can be due to causes such as issues in the construction schedule, errors in the design, improper construction and materials do not conform to the requirements.

*Table 1: Rank of the Contractor related causes of delay based on the frequency of occurrence*

| Code | Cause of Delay; Contractor related | Response | | | | | Frequency Index | Rank |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | | |
| D01 | Poor site management and supervision | 1 | 1 | 3 | 9 | 21 | 0.874 | 2 |
| D02 | Poor communication and coordination | 1 | 2 | 2 | 12 | 18 | 0.851 | 5 |
| D03 | Ineffective project planning and scheduling | 0 | 1 | 3 | 12 | 19 | 0.880 | 1 |
| D04 | Resource shortage (material, labor, machinery, and equipment) | 1 | 2 | 10 | 13 | 9 | 0.771 | 7 |
| D05 | Rework due to errors during construction | 1 | 0 | 4 | 12 | 18 | 0.864 | 3 |
| D06 | Inadequate cash flow management (Financial difficulties of the Contractor) | 0 | 1 | 15 | 12 | 7 | 0.763 | 9 |
| D07 | Inappropriate construction methods | 4 | 4 | 11 | 11 | 5 | 0.663 | 11 |
| D08 | Insufficient quality control | 2 | 11 | 9 | 10 | 3 | 0.611 | 13 |
| D09 | Inadequate contractor experience | 6 | 7 | 7 | 9 | 6 | 0.606 | 14 |
| D10 | Equipment failure/ breakdown | 5 | 8 | 8 | 11 | 3 | 0.594 | 15 |
| D11 | Conflicts between the contractor and other parties | 1 | 8 | 11 | 9 | 6 | 0.651 | 12 |
| D12 | Low productivity of labor | 1 | 1 | 4 | 14 | 15 | 0.834 | 6 |
| D13 | Slow preparation of shop drawings and samples of materials | 1 | 2 | 10 | 15 | 7 | 0.743 | 10 |
| D14 | Delay payment to supplier/subcontractor | 1 | 1 | 13 | 14 | 6 | 0.765 | 8 |
| D15 | Slow and poor decision-making process | 0 | 3 | 1 | 13 | 18 | 0.863 | 4 |

According to the table (*Table 01*) the fourth most significant cause of contractor related delay is slow and poor decision-making process (D15). The key reason for slowdown decision making is the Contractor's slow inspection of the decision-making procedure. Poor communication and coordination (D02) ranked as the fifth most frequent cause for contractor related delay. Difficulties in coordination between several parties of the project, poor information dissemination and attitude of the parties can be identified as the reasons for this. According to the analysis, insufficient quality control, inadequate contractor experience and equipment failure/ breakdown were ranked as the three least leading Contractor related causes of delay in Sri Lankan construction context. That means these factors do not take place often in the industry and have a very slight impact on delays.

## Conclusion

As per the results, it was found that delays which are attributable to contractors are still happening in the Sri Lankan construction industry. Through this study 15 causes of contractor related delay were identified, and they were ranked based on the frequency of occurrence of every cause of delay. Ineffective project planning and scheduling, poor site management, supervision, and rework due to errors during construction were ranked as the top three most occurring causes of contractor related delay in Sri Lanka. Furthermore, this study summarized 15 causes of delay attributable to contractors and one can carry out research in future suggesting delay mitigation strategies for reducing causes of delay explained in this study. By minimizing contractor related causes of delay success rate of construction projects in Sri Lanka can be increased and it directly contributes to enhance the overall performance of construction industry.

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# ENHANCING THE EFFECTIVENESS AND EFFICIENCY BY ADOPTING BUILDING INFORMATION MODELLING IN THE SERVICE DELIVERY OF THE QUANTITY SURVEYING PRACTICE OF SRI LANKA

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## Introduction

The global construction industry is moving in the direction of widespread application of BIM technique (Raic, 2007). In the worldwide construction sector, particularly in the Quantity Surveying field, there has been a paradigm change from traditional service delivery techniques to completely automated, by using BIM (Jayasena & Weddikkara, 2013). Jayasena and Wedikkara (2013) emphasized, implementation of BIM applications for the Quantity Surveying practice is a fear among Quantity Surveyors in Sri Lanka since the professional's existence is disturbed by the threatening and challenging nature created when employing BIM within the QS practice (Nagalingam, Jayasena, & Ranadewa, 2016).

The problem is to identify the factors contributing to the delay in using BIM in the QS contribution to the project. The QS needs to escalate the usage of BIM by understanding its potentials and developing streamlined methods to incorporate BIM into their current and future professional practices (Partridge, 2015). The main aim of this research study is to enhance the delivery of service in an effective and efficient manner by employing BIM applications within the QS practice in Sri Lanka where the objectives are to discover the current state of usage of BIM application in the Quantity Surveying field, to analyse the barriers influencing the implementation of BIM, to determine strategies to encourage the use of BIM to escalate the effectiveness and efficiency within the Quantity Surveying operations in Sri Lanka.

## Methodology

For this research, Pragmatism is the most suitable type of research philosophy because this study starts with a problem and tries to provide practical solutions that can be used in the future practice (Saunders et al., 2009). This research can be referred to as a Descriptive Research due to the wide range of surveys and fact-gathering inquiries, describing the current situation of the issues is the most essential goal (Kothari, 2004). Mix method is used as the research approach of this study where it combines both quantitative and qualitative methods (George, 2021). Surveys with closed-ended questions, observations where numbers are recorded, experiments and secondary data are comprised in this study where quantitative data are present.

In this study, qualitative data are included in literature reviews that evaluate concepts and theories and observations articulated in words, interviews with open-ended questions, focus groups, and secondary data.

For this research study, the questionnaire was distributed among randomly selected 45 Quantity Surveyors and purposively selected 5 Charted QS were interviewed among the population. The data collection methods used for conducting this research are listed below. Literature survey, which was undertaken to establish the research problem background and to obtain a solution to the research problem by articulating the objectives to be pursued. Close- ended questionnaires were utilized in this study as they included predetermined answers and required less time to complete. Structural interview survey was used to ask professionals' opinions regarding this study with pre-decided interview questions based on the requirement for the study. The responses compiled from the questionnaire were analysed using RII (Relative Importance Index) method, correlation analysis and regression analysis which are based on the hypothesis. Hypothesis was constructed based on dependent and independent variables of the study and firstly the reliability and validity of the questions in the questionnaire was identified. The interviewees' opinions were analysed by content analysis.

## Results and Discussion

The questionnaire distributed was responded by 45 Quantity Surveyors. Among the 45 Quantity Surveyors, 4 Charted QS, 21 Senior QS and 20 Assistant QS responded the questionnaire. Both the Pearson's correlation analysis and regression analysis showed that the relationship between independent and dependent variables are strong.

### *A. Current State of using BIM within the QS practice*

Most of the Sri Lankan construction organizations still uses manual methods in the QS practice, usage of standalone practice is high in Sri Lanka, and Architect is not formulating the BIM process and though sufficient details are available at design development stage, manual methods are used by QS to carry out their tasks vague through the detailed questionnaire. These indicate that Sri Lanka is a BIM infant country and lies in Level 0 of Bew- Richard model.

### *B. Barriers to implement BIM within the QS practice*

In the construction industry, according to the responses given by professionals regarding barriers to use BIM in the QS practice, lack of government influence (BA6) is the most significant hindrance of executing BIM within the QS practice of Sri Lanka. According to the content analysis results, unavailability of efficient computers, continuous power supply, continuous internet supply was identified as hindrances to implement BIM within the QS practice.

### *C. Strategies to encourage the use of BIM within the QS practice*

When considering the overall summary of the factors which act as strategies to encourage the use of BIM within the QS practice, it is essential to identify the most significant strategy as it brings numerous benefits to implement BIM to the QS practice of Sri Lanka. Thus, according to this study, the most significant strategy is government imposing regulations and develop the National BIM standard and National BIM execution plan while the least impacted strategy is addition of BIM as a compulsory module. According to the content analysis results, addition of practical sessions on QS related BIM software, was suggested as a strategy to implement BIM within the QS practice.

## Conclusion and Recommendations

This research study was directed to promote BIM within the QS practice. Literature surveys from past research findings and a detailed questionnaire survey were conveyed to ascertain the present state of using BIM, identify the barriers and strategies. A semi structured interview survey was conducted along with the attempt to gather the perspectives of the professionals in the field of QS to govern the contemporary status of using BIM and to elaborate the most significant barrier and strategy that encourage the use of BIM within the QS practice of Sri Lanka. To accomplish the three prominent objectives, Pearson's correlation analysis, regression analysis and RII were used along with content analysis to analyse the findings.

Over the recent years in the new millennium of the QS practice, it is evident that the BIM has extended to a remarkable popularity and in general, BIM was increasingly recognized worldwide. According to the Bew-Richards BIM maturity model, Sri Lankan QS practice lies in the 'Level 0' as still conventional manual methods are being used by Quantity Surveyors. Thus, Sri Lanka can be considered as a BIM infant country. The findings concluded that the integration of BIM in QS practice is very low. According to the RII analysis, the most significant barrier that hinders the adoption of BIM is lack of government influence. The opinions of interviewees too concluded that the major hindrance is the lack of government influence.

Through a thorough literature review, strategies to encourage the use of BIM within the QS practice were distinguished, and the responses of the questionnaires were ranked using the RII method to determine the most significant strategy that is used to promote the incorporation of BIM. Government imposing regulations and developing the National BIM guidelines and action plan obtained the highest ranking. The interviewees proposed that BIM should be standardized and the knowledge on BIM protocols should be shared among the QS professionals to enhance the usage of BIM within the Sri Lankan QS practice.

Recommendations were proposed through a deep analysis, according to the overall outcomes of this study. The base for the recommendations is the past research outcomes and the recommendations gained through the experts when carrying out the interview.

The interviewees recommended conducting practical sessions on QS based applications related to BIM, high-capacity machines should be available along with continuous internet supply as the entire country covers and power supply. Through the detailed questionnaire survey, it was recommended that realizing the merits and value of BIM, the government should pave the path to adopt BIM by imposing rules and regulations, policies, action plans, standards and using BIM in their projects and make application of BIM compulsory in all construction projects, which will facilitate to employ BIM rapidly within the QS practice of Sri Lanka.

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# FOREST FIRE RISK ZONATION MAPPING USING GIS AND REMOTE SENSING: A CASE STUDY IN BADULLA DISTRICT, SRI LANKA

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## Introduction

Forest fires are the main reason for changes in the structure of the forest coverage. According to the records of the Forest Department, Sri Lanka, as a percentage, more than half of forest fires were recorded in Badulla District. Badulla district is vulnerable to forest fires every year. It is one of the major natural disasters in Badulla district. It is not possible to control nature and natural disasters but possible to map forest fires and reduce their vulnerability. The identified problem of the study is, not having a proper forest fire risk zonation map for Badulla district, Sri Lanka. The main objective of the study is to analyse forest fire vulnerability and prepare a forest fire risk zonation map for the Badulla district. The study is based on Remote Sensing and GIS data. Those are the best methods for forest fire mapping beyond traditional methods.

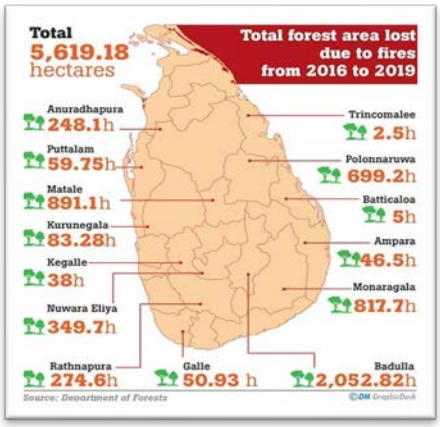


*Figure 1: Total forest cover lost due to forest fire from 2016 to 2019*
*Source: Forest department, Sri Lanka*

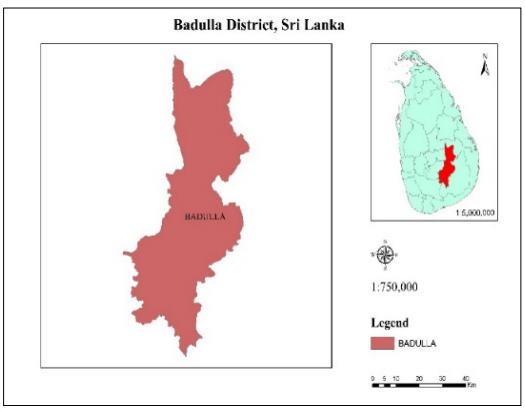


*Figure 2: Study area*

Traditional approaches make it challenging to map the intensity of fires. Topography, Land cover classes, and anthropological activities were taken as the variables of the study. Accordingly, the forest fire index was developed and given the ranks to variables variated from high to low. Further, a Forest fire risk zonation map was prepared and finally, a model was validated by calculating the RMSE value.

The study's findings may help policymakers take precautionary measures by reducing the danger and consequences of forest fires. Hence, a proper risk mapping of forest fires in the Badulla district is a timely requirement of the country.

## Methodology

Badulla district of Sri Lanka is the case study of the research as shown in Figure 2. In the current situation, Badulla district shows the highest forest fire vulnerability (Heenatigala, 2021). According to the past recordings of the Forest Department, a significant fire destroyed about 20 acres of land in Ravana Ella, Badulla, in 2016. In 2018, at least 156 forest fires were recorded in Sri Lanka, with 80 of them occurring in Badulla district. In 2017, there were more fire occurrences in Sri Lanka, according to the Disaster Management Center, with half of them being reported in the Badulla area as shown in Figure 1. The input data on elements that influence forest fires are presented descriptively and identify the factors that increase the risk of a fire. For the GIS analysis that followed, the descriptive data was turned into a forest fire risk index and a grading system, so that appropriate conclusions could be reached by computing and other mathematical procedures. Vegetation, topography, road network, and proximity to the settlement were examined in order of importance, as elements that affect a location's fire risk (Parajuli et al., 2020). Each factor's impact on the likelihood of a forest fire was evaluated, and the various classes of each factor were given the appropriate weights along with the forest fire index and classified by given scaled values from very low to very high. The percentage of each factor was calculated and then weighted along with the influence of forest fires and then all the factors were overlaid in ArcGIS (Parajuli et al., 2020).

FRI = 45%LC +15%S + 15%DR + 15%PS + 5%A + 5%DEM (1)

Where,

FRI - Fire Risk Index
A-Aspect
LC - Land cover
LST- Land surface temperature
S- Slope
DR - Distance from the road
PS - Proximity to settlement

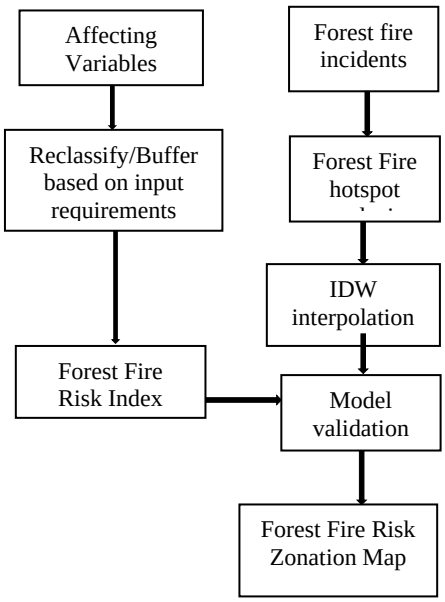


*Figure 3 : Methodology implemented over the study*

As a result, the risk model was created using equation 1 shown below following previous studies. Since the model was developed using six different independent variables, separate data on the frequency of forest fire incidents were used to validate the map. Beginning with the concept that high-up fire counts equate to a higher risk rating in the assigned category, recorded fire counts were overlaid in each fire risk zone. Using the forest fire incident data, forest fire hotspot analysis was carried out, followed by the creation of an IDW interpolation surface and the calculation of the RMSE value to verify the model. Following Figure 4 implemented the comparison of three maps. In order to three maps can be identified the same area of the three maps was vulnerable to occurring forest fires.

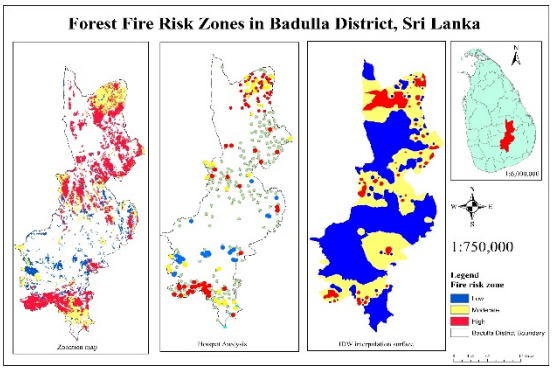


*Figure 4: Comparison of three maps*

## Results and Discussion

Nature cannot be controlled, but it is feasible to map the areas where most likely to have forest fires and so reduce the frequency of fires, avoid damage, etc. The places known as "forest fire risk zones" are where fires are most possible to start and easily spread to neighboring areas. Critical components of fire control include anticipating the variables that cause fires to occur and comprehending the dynamic behavior of fire. A fire risk zone map must be provided to accurately assess forest fire issues and decide on appropriate remediation strategies. Results were analyzed according to the objectives of the study. Hotspot analysis is a spatial examination and planning procedure inspired by the recognizable proof of grouping of spatial peculiarities. These spatial peculiarities are portrayed as focuses in a guide and allude to areas of occasions. According to the forest fire risk zonation map (Figure 5) in Badulla district, Mahiyanganaya, Ridimaliadda, and Haldummilla, DSD divisions are mostly influenced by the forest fires in Badulla district. Figure 6 illustrates how the vegetation types are affected by the forest fires from the year 2009 to 2019. Shrub land areas are mostly influenced by forest fires. The overall study area was 2861 square kilometers, and 49% of it was forested, along with the land cover class map. 27% area was shrubland from the total forest area of Badulla district. Due to its high sensitivity to fire damage, shrubland has nearly disappeared from much of the study region yearly.

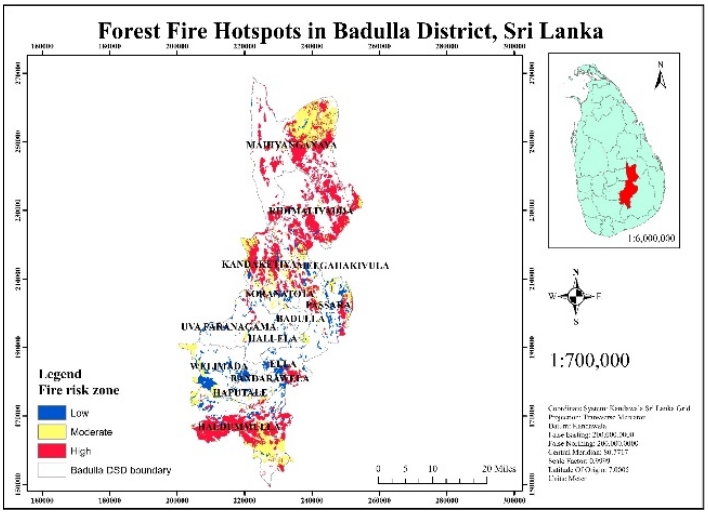


*Figure 5: Forest fire risk zonation map*

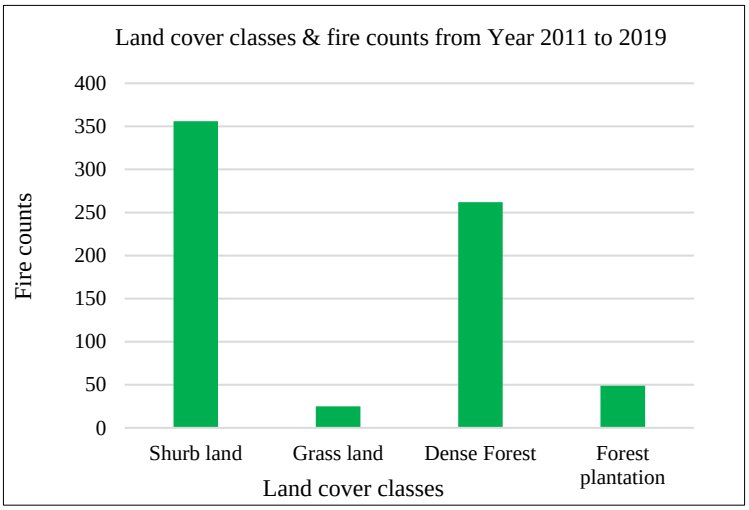


*Figure 6: Land cover classes and fire counts*

## Conclusion

Traditional methods of forest fire analysing require more ground data collection and are time-consuming. Consequently, RS and GIS technology is beneficial for preparing forest fire prediction models. If there may not be any records of the area's previous vegetation, it also is the main problem when using conventional methods. Therefore, RS and GIS may help to develop forest fire mapping also, are useful for monitoring healthy vegetation cover, burned vegetation, and fire risk zoning. One of the main limitations of the study that identified is, there was no database management for the forest fires in Sri Lanka.

Hence faced so many difficulties while taking the data regarding the forest fires. Therefore, it is preferable to switch from manual book-keeping to a database management system for organizing and retrieving the data connected to forests to continuously measure forest fires and maintain an appropriate web-based fire management database- a timely requirement of the country. This study can be developed with many independent parameters. Such as climate patterns (Wind direction and wind speed). Forest fire management is also very important. Therefore, develop forest fire management for Badulla district, Sri Lanka by introducing vegetation implementation, Fire belts, Firefighting reservoirs, and establishing sufficient fire brigades, etc as further studies. Not only for the Badulla district but The case study can also be developed into the forest fire analysis for the areas where on the forest fire belt which is introduced by the forest department in Sri Lanka (Sandamali and Chathuranga, 2021).

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# STUDYING THE SHORELINE VARIATIONS BASED ON THE MONSOON SEASONALITY IN MIRISSA

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## Introduction

Sri Lanka is an island consisting of a 1600 km long shoreline. The shoreline is the boundary between the ocean and the land. The coastal area of Sri Lanka provides a different range of natural resources and the most effective conditions for economic and social development. Coastal areas are threatened by natural and human activities and regular erosion. Some reasons such as unauthorized constructions, unplanned manmade barriers, changes in the rainfall, sea level rise, mean tidal range, mean wave height, coastal slope, and land use pattern shoreline were changed (Pusella, 2015). The major cause of changes in shoreline position in coastal zones is the accretion or erosion of sand. Coastal management needs to recognize how sand accretion and erosion are affected by monsoon seasonality and human impacts to implement the most effective coastal protection techniques. Shoreline change is named coastal erosion and it became a major problem in many regions of the world and is particularly important for countries in low-lying coastal areas such as the south coasts of Sri Lanka. As an example, in Weligama Bay in the south, about 175000 to 285000 $m^2$ of the coastal land area is lost due to erosion in the year (Lowry and Wickremeratne, 2012).

Mirissa is a small town on the south coast of Sri Lanka, located in the Matara District of the Southern Province. It is approximately 150 kilometres south of Colombo and is situated at an elevation of 4 meters above sea level. This area is in Sri Lanka with the Global Position System (GPS) coordinates of 5°56'53.7432" N and 80°28'17.7168"E. Mirissa Beach makes a popular tourist destination. Further, Mirissa coastal area consists of a fishery harbour and one of the island's main whale and dolphin viewing sites (Brinkhoff & Thomas, 2012). Mirissa area immensely helps to develop the economy of our country. However, improvement of this economic destination is not considered by the relevant authorities. This study mainly focuses on the detection of shoreline changes and geomorphological changes in Mirissa, on Sri Lanka's southern coast.

The shoreline time series were obtained using the "CoastSat" software. The toolkit uses Google Earth Engine's capabilities to quickly retrieve Landsat and Sentinel-2 photos cropped to any user-defined area of interest. With a precision of 10 m, separation was used to map the location of the shoreline (Vos, Splinter, Harley, Simmons, & Turner, 2019)). By using CoastSat a precise output can be gained for the small beach area. But using Sentinel -2 images, an accurate comparison can be obtained to the Landsat images. Determining the shoreline variation according to the

monsoon seasonality and identifying the geomorphological changes in Mirissa coastal area are specific objectives of this study.

## Methodology & Experimental Design

Figure 1 below describes the methodology that has been used in this study. The steps represented in the workflow diagram were applied to the selected area to get the results.

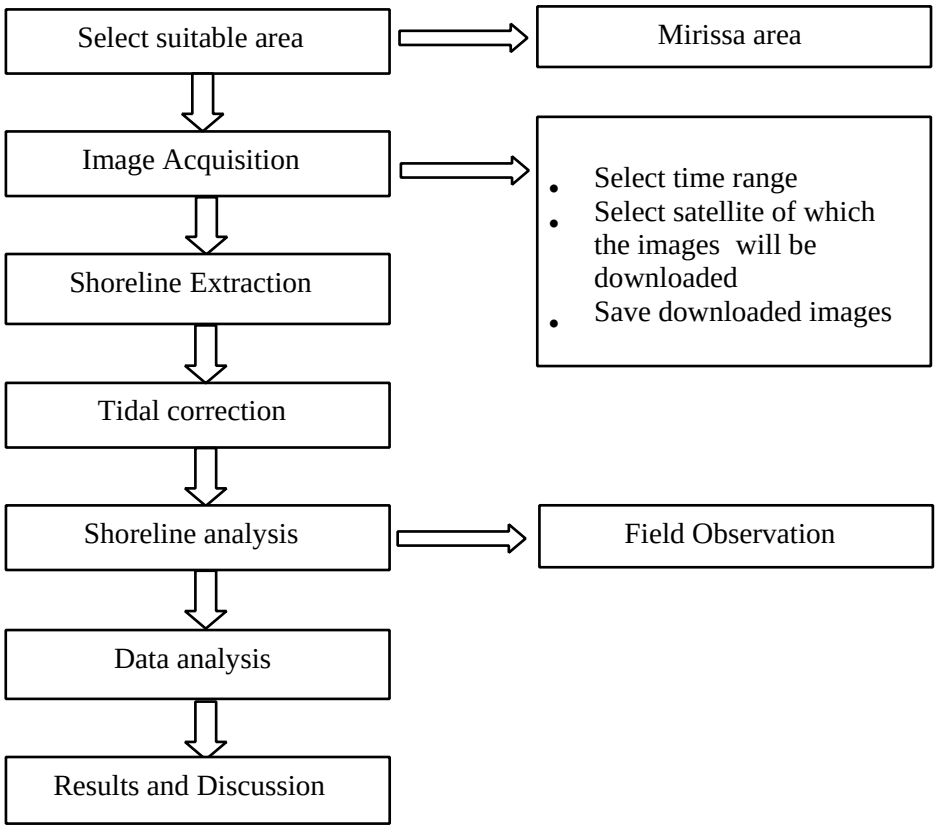


*Figure 1: Workflow diagram*

In Mirissa 2 km long shoreline was inserted into the 'CoastSat' software. After retrieving 286 photos and completing pre-processing and classification, 65 images were chosen for shoreline analysis and the retrieved shorelines at the location have been corrected for tidal effects. A graph was created for the analysis utilizing the "CoastSat" data and a time series of shoreline changes along each transect. Using the comparison of the shoreline retrieved by "CoastSat" with field survey data obtained using GNSS, the accuracy of the shoreline was verified. Also, for each transect location, the overall beach state in the Mirissa coastal zone was determined.

## Results and Discussion

The beach was in three states, according to the data analysis: erosion, accretion, and steady state. Additionally, the majority of transect locations exhibit a similar beach state, which is favourable for the development of the tourism industry.


*Figure 2: Shore normal transect locations*

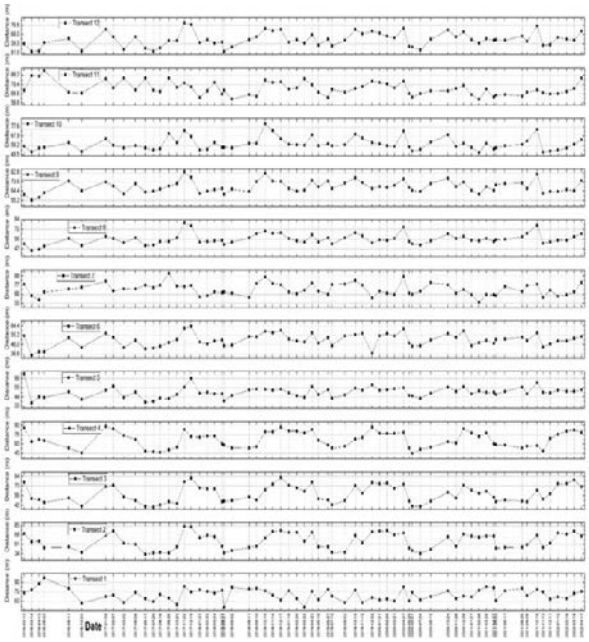


*Figure 3: Transect based shoreline variation*

The average horizontal shoreline difference (based on "CoastSat" and field measurements) was 7.899 ± 1 m, which is within the acceptable range. Therefore, satellite images acquired from the Google Earth Engine and "CoastSat" can be utilized to assess shoreline change detection very successfully with the proper tidal correction when there is a limitation of long-term field data in the area.

*Table 1: Overall beach state*

| Transect No. | No: of Shorelines Extracted | Time Frame | Distance between the shorelines of the moving (OL) and following (YG) proceeding in meters | | Overall-Beach State | Mean (m) | Standard Deviation |
|---|---|---|---|---|---|---|---|
| | | | Gain | Loss | | | |
| Transect_1 | 65 | 2016 - 2022 | 02 | | Steady State | 70.68 | 09.17 |
| Transect_ 2 | 65 | 2016 - 2022 | | 04 | Steady State | 56.89 | 14.29 |
| Transect_ 3 | 65 | 2016 - 2022 | | 06 | Steady State | 58.84 | 12.08 |
| Transect_ 4 | 65 | 2016 - 2022 | | 07 | Steady State | 67.00 | 12.67 |
| Transect_ 5 | 65 | 2016 - 2022 | | 19 | Erosion | 49.75 | 06.25 |
| Transect_6 | 65 | 2016 - 2022 | | 00 | Steady State | 50.53 | 06.13 |
| Transect_7 | 65 | 2016 - 2022 | 02 | | Steady State | 71.61 | 07.11 |
| Transect_8 | 65 | 2016 - 2022 | 14 | | Accretion | 55.94 | 07.74 |
| Transect_9 | 65 | 2016 - 2022 | 13 | | Accretion | 68.76 | 05.75 |
| Transec_10 | 65 | 2016 - 2022 | 06 | | Steady State | 59.78 | 06.43 |
| Transect_11 | 65 | 2016 - 2022 | 12 | | Accretion | 74.28 | 06.87 |
| Transect_12 | 65 | 2016 - 2022 | 11 | | Accretion | 63.51 | 06.46 |

## Conclusion

The constant state beach can be seen in many transect places in Mirissa depending on the general beach condition. For the beach state, values (loss or gain) less than 10 m are defined as steady-state values. The steady-state beach in Mirissa is due to fluctuations in monsoon seasonality, the orientation of the shoreline and the local wind pattern. Based on the seasonality of the monsoon, the general beach condition in Mirissa exhibits more than 10m of sand accretion and erosion. As a result, Mirissa Beach is ideal for leisure activities and the tourism sector. All monsoon seasons result in sand erosion and accumulation (southwest, northeast, 1st inter-monsoon, and 2nd inter-monsoon).

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