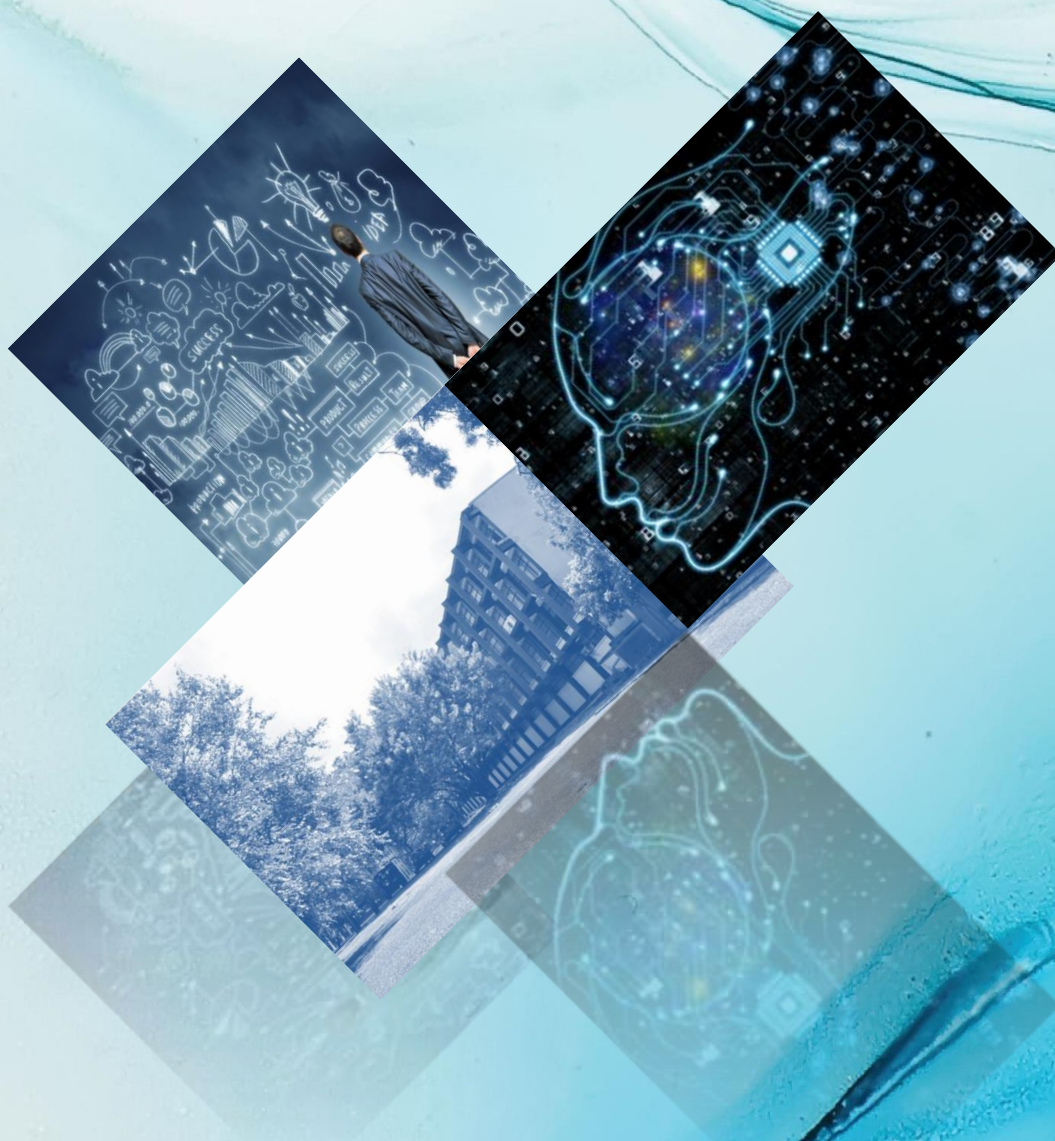


Volume 1, Issue 1



UOM RESEARCH DIGEST

Connecting Academics, Practitioners and Society



UNIVERSITY OF MORATUWA
SRI LANKA

#UoMResearchWeek2021

#UoMResearcher

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UoM Research Digest

Connecting Academics, Practitioners and Society

November – December 2021

RESEARCH WEEK 2021
UNIVERSITY OF MORATUWA
SRI LANKA

#UoMResearchWeek2021

#UoMResearcher

PREFACE

Welcome to the UoM Research Digest 2021.

As a pioneering national research institution, the University of Moratuwa is delighted to launch UOM Research Digest 2021. This publication chronicles the impact-oriented research of University of Moratuwa. The publication exemplifies the capabilities, accomplishments, and effects of research conducted by various research groups at the University. In par with the theme of the UOM Research Week 2021, the Research Digest serves as a platform to communicate and connect with the stakeholders including, industry partners, academics, students, and scholars.

We have set aside space in this issue for our multidisciplinary research centers, faculty and department level research groups/ projects to showcase their contribution to the respective fields of study. Moreover, we have provided space for our scholars currently reading for PhDs, MPhils and MScs to share knowledge on their ongoing research work. We are celebrating the inaugural issue of the UoM Research Digest, which has been made available online and in-print in an attempt to reach a wider audience.

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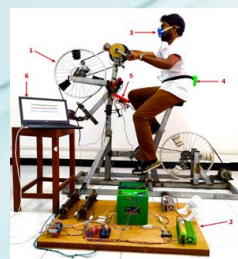
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MPhil Research Studies
MSc Research Studies



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Ms Miyami Dasandara

MESSAGE FROM THE VICE-CHANCELLOR

It gives me great pleasure to welcome you to the inaugural Research Week of the University of Moratuwa (UoM). The central theme of the event is to connect academics, practitioners and the society to uplift impactful research, starting from 30th November 2021. The event will continue for a week, which will include three major conferences from our faculties – Architecture, Business and Information Technology, a Global Research Forum connecting UoM to the world, a Postgraduate Day, and showcasing our undergraduate research and the cutting-edge work of our specialized research centers. The UoM researcher would be given pride of place as it is that endeavor which enable us to speak to the wider world with great esteem. I hope that we would make this event an annual feature in the University Calendar allowing research at UoM to realize its potential.

I wish to thank and welcome our keynote speaker, Professor Mohan Munasinghe, an eminent Sri Lankan who has strong connections with UoM, for agreeing to address us in the very first day of the week long research event. Your presence would definitely add an immense encouragement to all of us!

I appreciate the work of the organizing team of the Research Week and would also like to convey my gratitude to all the industry sponsors who partnered with the organizers to make this event a reality.

Finally, I welcome all of you from across the world who would join us from different time zones and adding value to this effort.

I wish you all the very best and an effective and productive week on UoM Research.

Prof. N.D. Gunawardena
Vice-Chancellor
University of Moratuwa



MESSAGE FROM THE DEPUTY VICE-CHANCELLOR

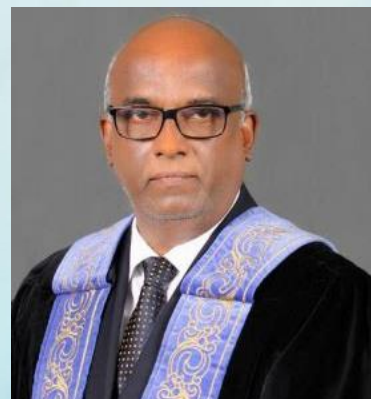
I am delighted to welcome you all to the maiden University of Moratuwa Research Week; organized by the Faculty of Graduate Studies with the partnership of Office of Research, Faculties of Architecture, Business, Information Technology, Engineering and Medicine. The trying times we face today has made this event to be conducted as a hybrid event, with a silver lining, enabling many more to participate from all four corners of the world. My warm appreciations to Professor Mohan Munasinghe - an illustrious Sri Lankan - who is our main keynote speaker for the event.

As we aspire to be a world class higher educational institute, excellence in research is an imperative to us. We strongly believe that the research carried out at the University should reach the wider academic community, practitioners, and the society. Hence, the Research Week 2021, the first ever at University of Moratuwa is of paramount important to us in achieving this reach. We are happy to provide a conducive space to carry out research at University of Moratuwa and the results showcased would bear testimony to the fact.

I congratulate the organizing team for developing an eventful week of celebrating and advancing research and would like to thank all the faculties who came together to hold their annual research conferences within a week and all others who are giving their time and energy to make this event a success. I see the value of multiple events lined up for the week. It is quite pleasing to see University of Moratuwa growing into a Global Research University.

I wish the event a success.

Prof. P.K.S. Mahanama
Deputy Vice-Chancellor
University of Moratuwa



MESSAGE FROM THE DEAN, FACULTY OF GRADUATE STUDIES

This may be the times of a virus keeping many of us at bay, yet it is with pleasure that I see the University of Moratuwa having its inaugural Research Week going live from the 30th of November to the 4th of December. The Faculty of Graduate Studies continued with the direction of Professor Dileeka Dias and the former Faculty Board which identified the usefulness of a research week. Current Faculty Board was fully behind this and worked to ensure that the Research Week becomes a reality. It is hoped that in future, all research conferences would happen in this period and that the week would be an annual fixture in the University Calendar.

My sincere appreciation to Professor Mohan Munasinghe for agreeing to be the keynote speaker during the inauguration of the UoM Research Week. Presence of Professor Munasinghe, who is the 2021 Blue Planet Award Winner and IPCC Vice Chair at the time of receiving the Nobel Peace Prize, is a great source of inspiration for us. We appreciate and are grateful to all the industrialists who are partnering with us. Research to make any impact should reach the society and must ensure transforming the economy. It is the expectation of this event to strengthen the researcher, practitioner and the society network.

Faculty of Graduate Studies applaud the effort and commitment of the organizing team of the inaugural research week. The team was led by Professor Udayangani Kulatunga and comprised of Dr Ajith Pasqual, Dr Anuradha Waidyasekera, Dr Lochandaka Ranathunga, Dr Sanka Sachithra, Mr Samadhi Rathanayake, Ms. Sathya Ramanayake, Dr Surangika Ranathunga, and Dr Upeksha Ganegoda, representing all faculties. Having agreed to position three of the faculty annual research conferences during this week, the three research directors Dr Sumanthri Samarawickrama, Faculties of Architecture, Dr Thesara Jayawardane, Faculty of Business and Dr Sagara Sumathipala, Faculty of Information Technology paved the way to ensure this research week to happen. The hard work of staff at Faculty of Graduate Studies, student volunteers and influencers and all those who are joining in multiple ways are greatly acknowledged.

The organizing team has embedded a series of events around the three research conferences making the week an informative and an exciting event to attend. With parallel to the inaugural research week, we launch UoM Research Digest to showcase the research carried out within different industry-sponsored research centers across UoM and to provide insight into the work of UoM researchers. The pandemic has ensured that the whole event would have its digital record enabling all others to revisit once again.

Something good and useful should not be just another event. It is hoped that the UoM Research Week would become an annual event as a permanent fixture in the University Calendar. With an annual fixture to flex their research excellence, Faculty of Graduate Studies believes that the #UOMresearcher has earned the rightful place in this space of Bolgoda Plains.

Prof. Ajith de Alwis

Dean

Faculty of Graduate Studies

University of Moratuwa



MESSAGE FROM THE DIRECTOR, RESEARCH

The University of Moratuwa recently accelerated activities to expand its research horizon in line with its vision and mission. The Research Week is one such effort to uplift the research culture at the university. The inaugural Research Week is organized by the Faculty of Graduate Studies jointly with all other faculties and the Office of Research of the university. The Research Week consists of three main research conferences and other exciting sessions. The Research Digest is published parallel with the Research Week to showcase and promote the current research at the University of Moratuwa.

The Research Week allows an important engagement and interaction of the academic and student community in all faculties and centers in the university. We expect that the activities of the Research Week will extend beyond the academic and student community to reach industrialists and policymakers for meaningful collaborations.

I would like to appreciate the untiring efforts of all the organizers of the Research Week and the editorial team of the Research Digest. I am certain that you will enjoy the insightful and impactful activities of the Research Week.

Prof. Ruwan Gopura
Director/Research
University of Moratuwa



AT A GLANCE

NO. OF POSTGRADUATE STUDENTS

	2013	2014	2015	2016	2017	2018	2019	2020	2021*
M.Sc.	27	29	34	44	57	69	88	57	42
M.Phil	16	17	10	32	25	27	30	30	16
PhD	9	14	16	12	10	21	20	18	19

*Enrolments on going

NUMBER OF SRC GRANTS ANNUALLY OFFERED DURING THE PAST THREE YEARS

2019

Long Term – 58
Short Term – 28
Capital - 01

2020

Long Term – 14
Short Term – 36
Capital - 04

2021

Long Term – 25
Short Term – 31
Capital - 03

AHEAD RESEARCH GRANTS

Grants for research for innovation commercialization (RIC)

Funding

LKR 275 million

No. of Projects

7

Grants for development-oriented research (DOR)

LKR 200 million

5

Grants to support University-Business Linkage (UBL)

LKR 13 million

1



MULTIDISCIPLINARY RESEARCH CENTERS AND OTHER RESEARCH UNITS

- Data Science, Engineering & Analytics Research Center
- Center for advanced Robotics
- Center for Biomedical Innovations
- National Languages Processing Center
- Center for Supply Chain, Operations and Logistics Optimization
- Center for Advanced Mechatronic System
- Building Economics and Management Research Unit
- UoM Urban Lab – Center for Cities
- Center for Disaster Risk Reduction

INTERNATIONAL RESEARCH CONFERENCES AND SYMPOSIA

Moratuwa Engineering Research Conference
(MERCon)



International Conference on Information
Technology Research (ICITR)

International Conference on Business Research
(ICBR)



International Research Conference (FARU)

Symposium of Natural/National Language
Processing(SNLP)



The World Construction Symposium (WCS)

International Conference on Advances in
Highway Engineering & Transportation Systems



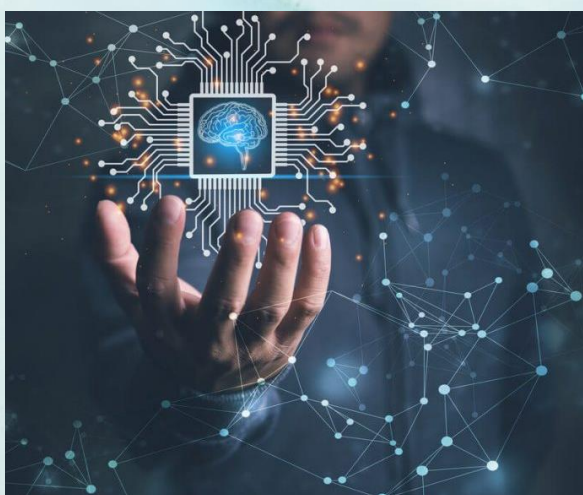
International Symposium on Earth Resources
Management and Environment (ISERME)



RESEARCH CENTERS AND UNITS

Multidisciplinary Research Centers

Multidisciplinary Research Centers facilitate synergistic collaboration among different faculties and departments, as well as with other local and foreign universities and industries. The Multidisciplinary Research Centers' research fields cut across and bring together the University's full realm of competence in a myriad of areas. Further, Multidisciplinary Research Centers collaborate with various stakeholder groups and industries to produce impactful research that goes beyond the university level to have a societal impact and assist academics and Early Career Researchers develop their capacity through local and international collaborations.



Research Units within the Faculties

Research Units of University of Moratuwa are established under each Faculty to promote interdisciplinary research and development activities among the Faculty members and students. The research units provide opportunities for its members to engage in cutting-edge research activities, takes local leadership in specialized research areas and enhance the research activities of University as a whole. The research units improve the external visibility and impact of our research through organizing annual international research conferences, symposia, and seminars.

THE CENTER FOR BIOMEDICAL INNOVATION- CeBI

The Center for Biomedical Innovation was established in 2017 as a multidisciplinary research center under the patronage of the Faculty of Graduate Studies of the university with the key mission of engaging in biomedical product development in Sri Lanka and the South Asian region. The founding director of the CEBI team is Dr. Pujitha Silva, while today's leadership team has been joined by Prof. Jagath Premachandra (lead - Projects), Dr. Aravinda Abeygunawardana (Lead - Projects), Prof. Ruwan Gopura (Lead - Research), Dr. (Mrs.) Gayani Nandasiri (Lead – Workshops and Media Handling), who comprise the Interim Committee. The CeBI was established as the shared mission of experts from multiple disciplines such as the Biomedical, Electronics, Mechanical and Chemical Engineering fields of the University of Moratuwa, Medical Science experts from the Medical Faculty of the University of Colombo, Business experts from the Postgraduate Institute of Management of the University of Sri Jayewardenepura as well as Industrial Experts. Today, 04 years later, the Center's collaborative partnerships have further expanded to include other local and foreign universities, medical institutions and industrial partners from around the country.

The University produces a vast number biomedical innovations and translational research activities through Undergraduate and Post Graduate level projects, but obstacles exist in terms of transforming them into real world products. While endeavors such as the University Business Incubator are highly supportive of student and staff startups from all fields, the CeBI was established to tackle the unique challenges in the biomedical field; the mandatory need for collaborations between the medical, technology and business fields, business case development, patient testing and ethical clearance, medical

device registration and standardization, continued biomedical research and development and product lifecycle management. Multidisciplinary collaborations, continuous learning from research to product development, skill development and growth of the team, the supportive, progressive and professional team culture are at the heart of the values of the CeBI. In 2018, the CEBI undertook its first main product development project, a 3-year project for developing Diabetic Footcare solutions for the rising population of diabetic patients in Sri Lanka and the region. The project is based on multiple years of undergraduate and graduate research conducted in the University of Moratuwa and the Department of Chemistry of the University of Sri Jayewardenepura, on an offloading material suitable for diabetic patients, which is funded today under the AHEAD Program of the World Bank. The project is now in its final stages of sealing commercial partnerships and conducting user testing following a successful filing of a local patent in 2020.



During the onset of the pandemic, the experts of the CeBI and its collaborators identified 03 timely projects to engage in and one such collaborative effort with an industrial partner has become fruitful in the development of an ICU bed which is in the product registration stage today, where the CeBI was able to provide support and expertise for the persevering product development work taken up by the industrial partner. As is common with product development and industrial endeavors, only a handful of efforts out of hundreds may fully succeed. Although not fully established in terms of products, the CEBI has engaged in multiple industrial efforts in the biomedical field such as developing a sleeping pod for a cosmetic industrial partner, developing sports analytics platforms for Sri Lanka Rugby and Sri Lanka Cricket, and introducing improvements for the electronic health record systems with the Health Promotion Bureau, Sri Lanka.



ICU bed designed and manufactured by CeBI and East link

Translational research and supporting innovative Biomedical education is the next main goal of the CEBI in order to spread the culture of progressing beyond research, multidisciplinary engagements and making a lasting impact on the future. The development of a spinal orthosis for adolescent scoliosis patients is a major TR project conducted in collaboration with the Imperial College London and the School of Prosthetics and Orthotics

Sri Lanka, which was successfully completed in 2020 utilizing funding obtained through the Global Challenge Research Fund and with findings published in the journal of Applied Sciences.

Another project undertaken with the same collaborators supported by the CeBI is improving newly developed external fixators with the use of affordable and readily available materials and manufacturing techniques. The CeBI mainly contributes industry and administrative coordination in this project.

The project for identifying a roadmap for improving the Health Information Management Systems in Sri Lanka was conducted in 2019, as an educational internship for the level 1 Biomedical Engineering undergraduates. The CeBI has organized and hosted multiple workshops and seminars related to Biomedical Product Development and Sciences to University audiences and the public including, the Industrial Night of 2018, Workshops organized with the Moratuwa Engineering Research Conference in 2020 and 2021, a collaborative workshop on Bionic Limbs with the Bionic Lab of the University of Moratuwa in 2021, and many other guest speeches conducted at the UoM.

With a growing team and strengthening collaborations in diverse fields at the heart of the CEBI, we continue to engage in product development, translational research and quality educational projects in the biomedical arena.



DIALOG-UNIVERSITY OF MORATUWA MOBILE COMMUNICATIONS RESEARCH LABORATORY

Established in 2005, this laboratory strives towards realizing the vision, *'To stretch the frontiers of applied communications technologies through research and development initiatives of national and regional significance by harnessing the leading edge technical capabilities inherent to Dialog, its parent, the Axiata Group Bhd and the University of Moratuwa'* under the directorship of Prof. Dileeka Dias and funded by Dialog Axiata PLC.

Objectives:

Develop innovative products and services based on present and leading-edge technologies for future markets

Diffuse technologies through commercialization vehicles, educational and specialized training programmes,

Develop an internationally recognized base of expertise in mobile technologies in the medium and long run

Establish the UoM and Dialog as leaders in uplifting the R&D capability in communications in Sri Lanka

Research Interests

- Embedded Wireless/Mobile System Design
- Industrial Internet of Things (IIoT)
- Mobile edge computing
- Wireless sensing and sensor networks
- 5G mobile technologies and applications

Successes:

Smart energy meter module: The module interfaces to a regular digital household energy meter, facilitating remote energy monitoring, remote disconnection/re-connection, and pre-paid facility through the establishment of a prepaid wallet on the meter through a secure communications channel. This research is a joint effort between the University of Moratuwa, Dialog Axiata PLC and Lanka Electric Co, (Pvt.) Ltd. (LECO) and was initially funded by a 186K GBP grant by the GSMA's Mobile for Development Utilities fund. As of Nov. 2021, 12,500 smart meters have been deployed by LECO at their customers' premises. Data storage, monitoring and analytics are supported by Dialog's IoT back-end. The smart energy meter system facilitates customer lifecycle management, wallet management, tariff management, load profile management and data analytics. This project has catalyzed the prepaid concept into realization in the near future in Sri Lanka which will be a significant development in the utility sector in the country. The smart energy meter is one in a family of smart grid products developed for LECO by the Lab.



Current Research

An end-to-end 5G network using open source and software-defined radio technologies, the testbed will enable the detailed study of 5G networks including the core and radio access network functionality, as well as the implementation and optimization of novel applications involving 5G's capabilities for low-latency, broadband and massive machine type communications. The testbed will add significant value to the teaching and research resources of the Department. The testbed will be extended and replicated in other universities under Dialog's 5G Innovation Center program.

Contact Information

Dialog-University of Moratuwa Mobile Communications Research Laboratory, Department of Electronic & Telecommunication Engineering, University of Moratuwa.



UoM Extension 3320



<https://ent.uom.lk/dialog/>

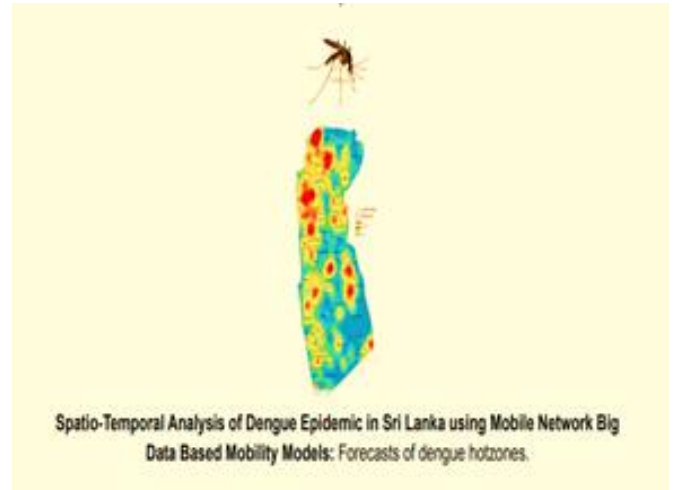


DataSEARCH aims to engage in research in data science, engineering, and analytics. The center envisions fostering collaboration amongst academia, practitioners, private and public sectors to conduct cutting edge research that enables the center to harness the power of big data to catalyse data-driven decision making in the Sri Lankan industry. To engage and promote research in data science engineering and analytics, the group conducts workshops and other activities to create awareness among students, faculty, and the local industry that has the potential to gain a competitive advantage by engaging in the science, engineering and the analytics of data. DataSEARCH was established in 2017 under the leadership of Dr. Amal Shehan Perera, the current Director of DataSEARCH. Research conducted by DataSEARCH is funded by AHEAD grants, SRC grants, and industrial collaborators.

Ongoing Research

Spatio-Temporal Analysis of Dengue Epidemic in Sri Lanka using Mobile Network Big Data Based Mobility Models

Dengue is the most rapidly spreading mosquito-borne virus and outbreak preparedness is an important element. Dengue epidemic forecasting requires multiple data sources and Human Mobility is a vital factor. CDR (Call Details Records) can be used to model user mobility. Existing risk-based mobility models compute risk scores for a given location based on domain intuition. Increased precision on the risk score might lead to improved forecasts for the epidemic model. A data-driven approach to find precise values for the risk score using sensitivity analysis, formulas and/or penalty based methods based on past data is explored.



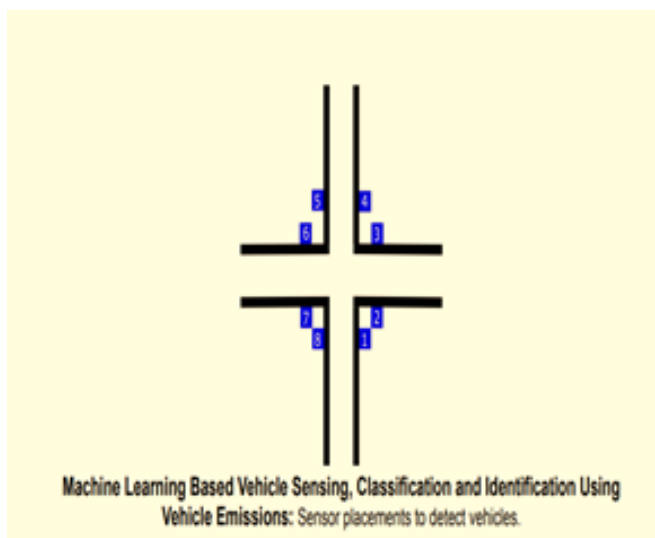
Developing a Retrieval-Based Tamil Language Chatbot for Closed Domain

Research in low-resourced language chatbot systems focuses mainly on machine learning based retrieval models. High inflexion and free word order pose key challenges to Tamil language chatbots. A practical challenge in using chatbots is that the users may not express themselves entirely in Tamil but in Tamil mixed with English. Currently available Tamil chatbots primarily suffer from these challenges even for a closed domain. Hence, a suitable approach to develop a Tamil language chatbot for the closed domain is explored.



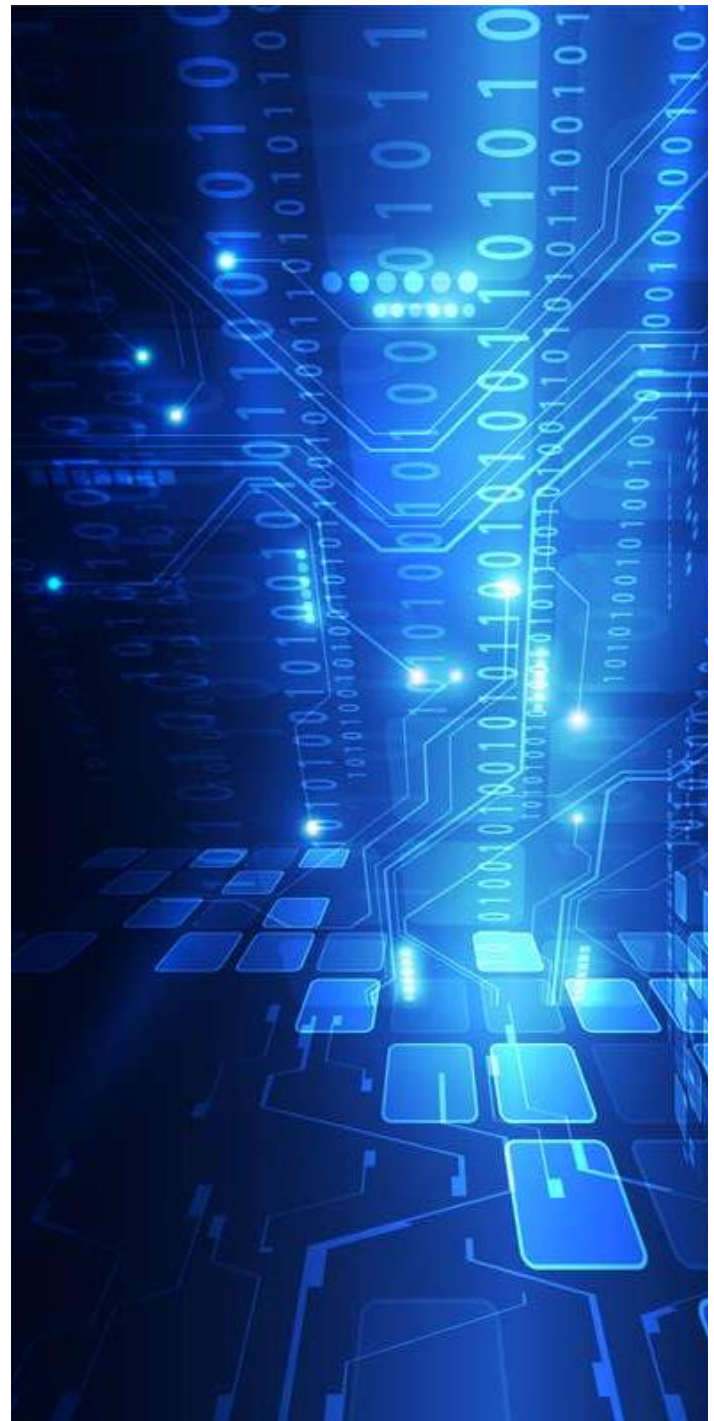
Machine Learning Based Vehicle Sensing, Classification and Identification Using Vehicle Emissions

Traffic count surveys which are traditionally conducted by manpower can be automated to improve efficiency and reduce cost. As video analysis faces criticism due to privacy concerns, alternate methods are necessary. Vehicles emit magnetic fields and radio frequencies (RF) while moving with the engine running. This research investigates the use of vehicle emissions to tag vehicles moving through an intersection and identify the path taken using Machine Learning. Successful completion of this project enables vehicle count surveys to be carried out with minimal manpower and equipment cost.



Completed Research

- SIGMALAW: Legal Information Extraction
- Travel Behaviour Analytics using GPS Probe Data for Public Transportation Services
- On Demand High Capacity Ride Sharing for Mobility on Demand (MOD) Systems
- Customer Profiling to Improve Service and Management of Mobility on Demand Systems.
- Affect Level Opinion Mining of Twitter Streams.
- Developing a Trip Distribution Model for Identified Mobility Groups Using Big Data.
- Forecasting Agricultural Crop Yield Using Remote Sensing Data & Machine Learning.



Contact Information

Contact DataSEARCH, University of Moratuwa.



UoM Extension 3320



datasearch@uom.lk



<https://uom.lk/datasearch>

INTELLIGENT SENSING MEASUREMENT AND CONTROL LABORATORY- IntelliSense Lab

The IntelliSense Lab or Intelligent Sensing Measurement and Control Laboratory is a research oriented lab established in Aug 2017, which focuses on bringing cutting edge technologies and computer science concepts together to formulate useful solutions for industrial and other real world problems. The main research areas of the unit are Robotics, Computer Vision, Embedded Systems and Networks, and IoT.

Objectives

- To conduct undergraduate and postgraduate research with industry collaboration and potential commercialization
- To facilitate engineering students to undertake serious projects with practical outputs.
- To facilitate delivering curricular course modules particularly in Integrated Computer Engineering with hands on embedded and robotic systems.
- To build and sustain national and international level collaborations for large scale projects spanning from day to day lives of public to innovative findings for future lifestyles



Successes so far

Open Data Sets

A.P.P.S. Pathirana, Fabric Stain Dataset, <https://www.kaggle.com/priemshpathirana/fabric-stain-dataset/metadata>

R.M.S. Ranathunga, G.P.P.D. Bandara, K.P.T.K. Bandara, R.A.T.K. Ranatunga, B.K.D.V. Vimarshana, Fabric Defect Dataset, <https://www.kaggle.com/rmshashi/fabric-defect-dataset>

Patents

C. D. Gamage, R. M. K. V. Ratnayake, S. J. Sooriyaarachchi, "A Robotic Device for Autonomous Navigation in Unstructured Cluttered Environment," National Patent LK/P/ to be assigned

C. D. Gamage, C. R. De Silva, G. H. S. I. Dharmaratna, P. S. H. Pallemulla, R. M. S. Ranathunga, R. A. S. K. Jayasena, R. M. K. V. Ratnayake, S. M. Kahawala, S. J. Sooriyaarachchi, "Method And Apparatus for Detecting Surface Defects," National Patent LK/P/21709, Apr 08, 2021

C. D. Gamage, C. R. De Silva, G. H. S. I. Dharmaratna, P. S. H. Pallemulla, R. M. S. Ranathunga, S. J. Sooriyaarachchi, "Real-Time Autonomous Fabric Quality Inspection System Using Optical-Input-Based Multimodal Feature Detection and Self-Learning Classification," National Patent LK/P/20880, Nov 27, 2019

G. P. R. T. Pathirana, C. D. Gamage, S. J. Sooriyaarachchi, "IntelliSenseLABZ IoT Board", Jul 06, 2021

C. D. Gamage, C. R. De Silva, G. H. S. I. Dharmaratna, P. S. H. Pallemulla, R. M. S. Ranathunga, R. A. S. K. Jayasena, R. M. K. V. Ratnayake, S. M. Kahawala, S. J. Sooriyaarachchi, "Computer Vision Based Multi-Spectral Automatic Fabric Quality Inspection Machine with Physical Color Referencing," National ID LK/I/13468, Apr 09, 2021

Ongoing Projects

FabVis - an automated fabric quality inspection system (AHEAD funded and industry collaborated),

AgrIoT - a network of Soil Sensors and Drones for precision agriculture (NRC funded),

Xavier - a multi robot system for 3D area exploration (industry collaborated)

Contact information

IntelliSense Lab, Department of Computer Science & Engineering, 2nd Floor, Sumanadasa Building, University of Moratuwa, Sri Lanka



0112 650 301



intellisense@cse.mrt.ac.lk



<https://uom.lk/cse/labs/IntelliSense>

Team Behind the Success

Current Team

Dr. Sulochana Sooriyaarachchi- Leader/ Founder

Dr. Chandana Gamage- Advisor

Dr. Chathura de Silva - Computer Vision & IoT Expert

Mr. Suresh Dharmaratne- Research Engineer

Mr. Kalana Ratnayake- Research Engineer

Ms. Tharushi De Silva- Research Assistant

Ms. Dilini Pasqual - Research Assistant

Ms. Shashikala Ranathunga- Research Assistant

Alumni

Mr. Aruna Jayasena- Former Research Assistant

Mr. Sachin Kahawala- Former Research Assistant

Mr. Sajith Pallemulla - Former Research Assistant

Mr. Manesh Jayawardhana- Former Research Assistant

Mr. Dineth Egodage- Former Research Assistant



BUILDING ECONOMICS AND MANAGEMENT RESEARCH UNIT –BEMRU

The Building Economics and Management Research Unit (BEMRU) is the research arm of the Department of Building Economics. BEMRU was established in 1990, identifying the need to enhance the department's research profile. A significant portion of the BEMRU's research is distinctive within the Building Economics and Management discipline due to its emphasis on extending the knowledge frontier through theoretical works, in contrast to the applied research that most other research institutes embark on. The BEMRU currently consists of eleven research groups with different research interests.

Vision - To enhance the research culture of the Department of Building Economics, by conducting research in construction, management and economics fields and disseminating our research through publications and presentations. We see the BEMRU as one of the leading university-based research units which conducts research related to the construction industry in Sri Lanka.

Mission - To increase opportunities to conduct research at the department by recruiting research staff; conducting MPhil and PhD programmes; organizing research conferences and presentations; through bidding for research projects. The BEMRU also encourages staff research by offering a research service center to department staff members and maintaining a live research information database.

Research Conferences and Projects Undertaken by the BEMRU

The BEMRU has engaged with many local and international collaborative projects on various topics funded by both private and government institutions.

World Construction Symposium: The Building Economics and Management Research Unit (BEMRU), Department of Building Economics, University of Moratuwa, Sri Lanka and the Ceylon Institute of Builders (CIOB) jointly organise the Annual World Construction Symposium since the year 2012. This annual symposium provides a forum for researchers and practitioners in the areas of built environment and construction worldwide to share their knowledge, experiences and research findings.

CHOBE/RICS: A project on the state of global surveying education - Robert Gordon University (UK); George Brown College, Canada; Obafemi Awolowo University, Nigeria; Federal University of Technology, Akure, Nigeria; University of Western Sydney, Australia.



FADRI: Facilitating Post-Disaster Recovery and Re-construction through Insurance - University of Northumbria, UK.

Transformational Homes for long term disaster relief and recovery: This involves the long-term development and enhancement of society's capacity to withstand disasters - University of Northumbria, UK.

Gender and disability inclusion in post-disaster rebuilding 'Build Back Better' programme: To improve the engagement of gender and disabled communities in disaster reconstruction programmes -London South Bank University, UK.

Cost benefit analysis of physical defences against natural hazards: University of Northumbria, UK.

Characteristics of a digital platform for supporting an early warning system for dam breaks in Sri Lanka: Analysis of the features of the MOBILISE platform to support an early warning system for Dam Breaks in Sri Lanka - Department of Irrigation, Sri Lanka and the University of Salford, UK funded by Quality-related Research (QR) funding.

Type of assessments required for considering disaster risks and their impacts during urban development projects: University of Salford, UK funded by Quality-related Research (QR) funding.

Career adaptivity: The effective adaptation of Quantity Surveyors to changing demands, a project collaborated with the Institute of Quantity Surveyors Sri Lanka (IQSSL).

Online platform for cost information database: A project collaborated with the Institute of Quantity Surveyors Sri Lanka (IQSSL).

Analysis of construction cost and materials and labour used for residential buildings in Sri Lanka: Industry funded project in collaboration with Tokyo Cement Group PLC and Institute of Quantity Surveyors Sri Lanka (IQSSL).

Contact Details

For any research collaborations, please contact Prof. (Mrs.) Yasangika Sandanayake, Director, Building Economics and Management Research Unit (BEMRU), Department of Building Economics, University of Moratuwa, Moratuwa.



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The 'UoM Urban Lab – Center for Cities' founded in 2017, is a multidisciplinary research arm anchored by researchers from different fields of expertise in the University of Moratuwa. It draws together the research and outreach energies of scholars of Architecture, Urban Design, Planning, Conservation, Environment Management, Transportation, Construction and Facility Management, Housing, Landscape, Real-estate, Land-use surveying, Urban Economics, Statistical modeling and urban studies.

Vision

To become the center of excellence in coordinating, facilitating and promoting research in the fields of urban planning, development and management of cities and assimilation of such knowledge and initiating links and partnership activities with industrial, public and governing bodies.

Ongoing Research

'UOM Urban lab – Center for Cities' collaborates with government, industry and community organizations and is currently involved in other activities such as annual international research conferences (ICCP, I3SC) and research journal publications on urban and public awareness programs. For the past few years, it undertook and coordinated industry based research/implementation projects and assignments of related government institutions in order to share knowledge and research experience on the issues to be faced in future cities.

Research Project

The 'UoM Urban Lab' – 'Center for Cities', University of Moratuwa conducts a research project funded by the World Bank for developing a Model to assess comfort, safety and security of public realm while comprehensively identifying issues related to streets and other public spaces designs, configurations, lay outing, intersection arrangements as well as the bordering-built facades etc. in relation to the user safety, security and comfort in Colombo city limits.



Contact Details

For further details contact Dr. Janaka Wijesundara, Director, Center for Cities.



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The Center for Disaster Risk Reduction in the University of Moratuwa was established in 2018 as a multidisciplinary research center to bring out Disaster Risk Reduction research outcomes that make an impact in Sri Lanka and the global context. It offers strategic input and practical guidance to disaster management policymakers and practitioners, promotes multi-disciplinary collaboration for Disaster Risk Reduction (DRR) research, development and teaching within the local, national and international context and develops and assists postgraduate research community researching on DRR within the university and in Sri Lanka.

The center has established a multi-disciplinary platform for researchers from different faculties in the University to collaboratively work to develop research outcomes for the enhancement of DRR activities in Sri Lanka. Further, the members have already established strong relationships with organizations working in DRR related activities such as the Disaster Management Center, National Building Research Organisation, Urban Development Authority, Land Reclamation and Development Authority, Irrigation Department and Center for Urban Waters, Sri Lanka. These linkages allow the research outputs through the center to be integrated into DRR practices around the country. The center also actively works with international universities on disaster-related research projects. With these local and international networks, the University has the opportunity to engage in real-world, high-impact research which is timely and appropriate, as well as to provide strategic directions and guidance for DRR related policy and practice.



Notwithstanding the research projects, the center has been effective in conducting research activities such as joint MSc supervisions, active participation in workshops and seminars conducted by government authorities and collaborating with other local/international universities. Moreover, the center collaborates for virtual research presentations on DRR for researchers and staff members.

At present, the center is involved in several important multidisciplinary and multi-hazard projects encompassing disaster risk mitigation and management, disaster resilience education, emergency response management, cultural and socio-economic aspects of disaster risk and development of relevant advanced technologies. The center has become one of the major contributors to the international collaborative research project titled “Multi- Agency Platforms for Building Resilient Communities (MOBILISE)- <http://www.mobilise-project.org.uk/>” led by the University of Salford, UK. This project aims at developing a digital infrastructure that can offer intelligence to a range of agencies to work together to reduce the impact of natural disasters on communities, focusing Sri Lanka, Pakistan and Malaysia.

As the Sri Lankan partner to this project, members of the center are engaged in four MSc. Studies under the following topics under the supervision of academics from Department of Building Economics;

- Digitally enhanced disaster preparedness approach to natural disasters in Sri Lanka
- Characteristics of a digital platform for an effective early warning system for dam breaks in Sri Lanka
- Investigation of barriers in policy implementations towards climate change adaptation and mitigation in Sri Lanka
- A framework to support risk-sensitive urban development in Sri Lanka

In addition, another team from the Department of Computer Science Engineering is working within the MOBILISE project on change detection and flood monitoring using synthetic aperture radar data. Further, the researchers of the center are actively participating in joint meetings conducted under the project and share Sri Lankan research outcomes with many international and local stakeholders related to DRR.

In another initiative, members from the DRR center, representing the Department of Earth Resource Engineering, Department of Computer Science Engineering and Department of Building Economics are involved in a project titled “Transforming Urban Development to Reduce the Impact of Natural Disasters” (TRANSCEND)-

<https://thinklab.salford.ac.uk/research/transcend/> aimed at transforming current urban planning practices by developing an advanced digital platform which allows stakeholders to take part in risk-sensitive urban planning. The project currently seeks Cabinet approval.

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THE NATIONAL LANGUAGES PROCESSING CENTER

The National Languages Processing Center (NLPC), at the University of Moratuwa has been developing the **SiTa** Computer-Assisted Translation System since 2018 which is funded by the AHEAD grant.

Government organizations need to produce official documents in all three languages – Sinhala, Tamil and English. So far this has been a manual process by human translators. Hence, the scarcity of human translators has been a bottleneck for these organizations in producing trilingual documents at the expected rate. Identifying the gap and the timely need, the NLPC has taken the initiative in producing the Artificial Intelligence-(AI) based **SiTa** translation system.

The National Languages Processing Center (NLPC), at the University of Moratuwa announces the **SiTa** Computer-Assisted Translation System for the translation of official documents in Sinhala, Tamil and English.

SiTa uses a state-of-the-art neural machine translation engine to translate documents. This translation is then checked and corrected by a professional translator and finally verified by a reviewer. It has improved both the accuracy and speed of translations with this three-step process. It also maintains the confidentiality of translated documents.

This service is now available to government institutions for the translation of documents from English, Sinhala or Tamil into one or both of the other languages. Documents which can be translated include:

- circulars
- reports and
- letters

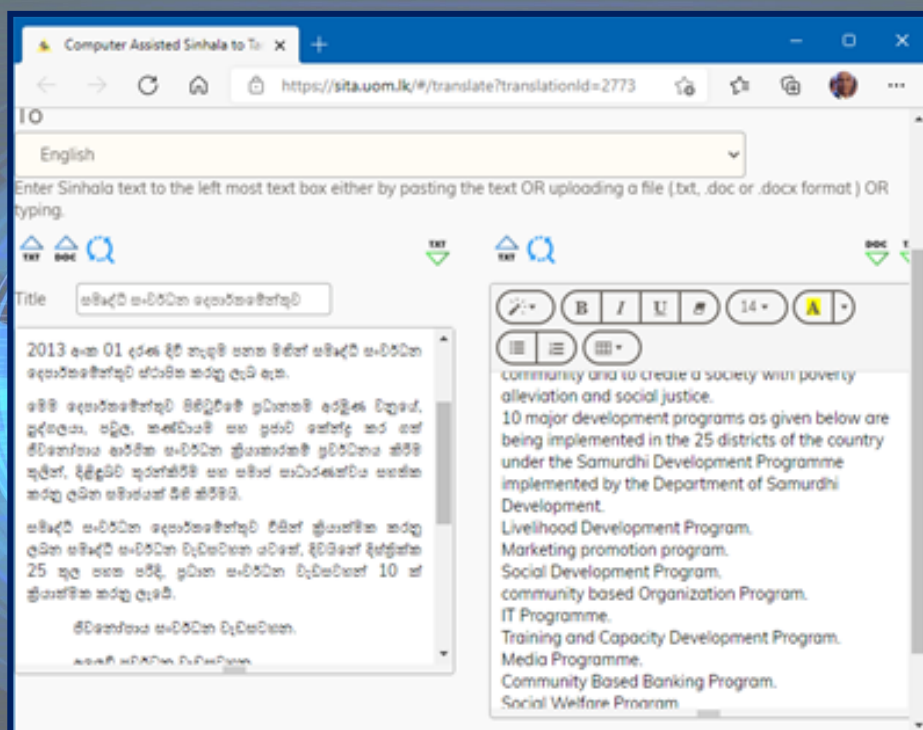
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https://www.uom.lk/nlp/news_events/professional-translation-service



CENTER FOR SUPPLY CHAIN, OPERATIONS AND LOGISTICS OPTIMIZATION- SCOLO

The Center for Supply Chain, Operations and Logistics Optimization (SCOLO) is the newest multidisciplinary research center at the University of Moratuwa (UoM). Freshly minted in 2021 Q4, the center concentrates on quantitatively driven research encompassing all facets of supply chain, operations and logistics. SCOLO was established through the vision of Dr. Niles Perera and Dr. Amila Thibbotuwawa, Senior Lecturers at the Department of Transport & Logistics Management, to fill the vacuum of quantitatively driven supply chain research in Sri Lanka while bringing state-of-the-art approaches from across the globe. It was heavily inspired by the acceptance of an international grant proposal submitted to the Norwegian Agency for Development Cooperation (NORAD).

The center is ably guided by the patronage of Prof. Amal Kumarage, Prof. Asoka Karunananda, Prof. Asoka Perera, Dr. Ajith Pasqual, and Dr. Ranil Sugathadasa, who are experienced researchers at UoM.

A unique feature of SCOLO is that it has an ensemble of six passionate young researchers cutting across three faculties who possess complementary expertise in Dr. Niles Perera, Dr. Amila Thibbotuwawa, Dr. Logeeshan Velmanickam (Dept of Electrical Engineering), Dr. Hirushie Karunathilake (Dept of Mechanical Engineering), Dr. Priyanga D. Talagala (Dept of Computational Mathematics), and Mr. Supun Gothama Hewawalpita (Dept of Decision Sciences).

SCOLO presently conducts projects encompassing numerous domains. The crown jewel of the center is the NORAD grant titled “Enhancing Lean Practices in Supply Chains: Digitalization” which is expected to commence with the approval of the Government of Sri Lanka. In addition to the above, SCOLO pays special emphasis on applications of forecasting, inventory, decision-making, life cycle analysis, sustainable circular economy, artificial intelligence/machine learning, augmented reality, operations research/management science, system dynamics, and blockchain technology on supply chain, operations and logistics. In addition to the faculty members, SCOLO is blessed with over a dozen talented postgraduate research students. Despite its relative youth, SCOLO has several accepted journal and conference publications already with several more under review in high impact journals.



SCOLO presently maintains research links with twenty universities encompassing four continents. This enables the UoM to improve its international visibility within the scope of SCOLO. Blessed with a list of highly cited international collaborators, SCOLO is presently working on several research projects aimed at contributing towards the body of knowledge as well as the community at large.

Contact Details

Those who seek further details on SCOLO are encouraged to contact Dr. Niles Perera, who has been nominated as the Founding Director of SCOLO.



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Center for Supply Chain, Operations and Logistics Optimization 



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The Center for Intelligent Transport System (CITS) of the University of Moratuwa was established in October 2017 to cater to the academic and industry gaps in transportation due to the absence of a platform for individual sector experts to work together for the betterment of transportation especially in the Sri Lankan context. The Center has been successful in collaborating with major departments of the university in collaborative research and industrial projects both with national and international partners addressing different aspects of transportation engineering.

With the vision, mission and scope given below along with a set of objectives aligned towards the industry, CITS is expected to be a major actor in terms of transportation engineering especially incorporating areas of advanced technology and sustainability.

Objectives:

- To contribute towards improving transport services in the country and the region using new technologies to achieve comfortable, safer, timely, environment friendly and fuel-efficient transport operation
- Increase inter-disciplinary research initiatives and dissemination of knowledge in the study area in terms of research publications, research degrees, training programmes, conferences and workshops
- Engage in state of the art, inter-disciplinary collaborative research and development work in the area of ITS

The Center operates with the participation of a number of senior academics and research assistants representing different academic departments of the university and is presently headed by Prof. J.M.S.J. Bandara. One of the major projects undertaken and being successfully carried out by CITS is the 'Multidisciplinary Transport Development Project'; under the Accelerating Higher Education Expansion and Development (AHEAD) Operation grant. Despite the prevailing world situation on travel restrictions, the ITS Center has been able to be in line with the initial planned timeline to achieve targets which will be of great importance to the transportation sector especially in the Sri Lankan context. A few of the projects recently completed or are nearing completion are;

- Real-time vehicle identification & counting and vision based adaptive traffic signal controllers
- Preparation of a Proposal for Global Environment Facility on Sustainable and Efficient Electric Mobility System in Sri Lanka
- Alternative Aggregate Solutions for Highway Pavement Material based on construction waste



Vision: To be the premier research center for ITS studies in the South Asian Region

Mission: To facilitate and promote inter-disciplinary research in the focus area of Intelligent Transport Systems (ITS) that cut across broad knowledge domains

Scope: Promote and facilitate inter-disciplinary research in the focus area of Intelligent Transport Systems that cut across broad areas of research interests

- Multimodal transport data analytics platform –Enhanced Probe Vehicle, Active road signs, Open road tolling mobile application
- V2X simulation platform and Autonomous vehicle controlling algorithms and communication protocols
- Integrated IoT-enabled Platform for monitoring, collecting and analyzing Traffic related environmental Information
- GPS based data collection and analysis system for bus passenger boarding and alighting counts
- Study on Lithium-ion Battery-Swapping Service Market for the promotion of Electrical Vehicles in Sri Lanka

Apart from the above, there are a number of projects of national importance that have been initiated at CITS transforming the CITS to be the major multidisciplinary research center for transportation engineering in the country. Finally, CITS is open for joint ventures on transportation related projects with any third party entity and remains to be where the best multidisciplinary experts in transportation engineering and intelligent transport systems can be met.



Contact Details

The center can be reached via mail to the Director Prof. J.M.S. Bandara of CITS



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<https://uom.lk/civil/divisions/transportation/intelligent-transportation-systems>

AHEAD RESEARCH PROJECTS



To support the higher education sector, Government of Sri Lanka together with the World Bank have introduced Accelerating Higher Education Expansion and Development (AHEAD) operation. University of Moratuwa has secured 13 number of AHEAD grants at the moment.

AN ANALYTICAL FRAMEWORK FOR DIGITAL SOCIAL MEDIA IN SRI LANKA

With the rapid growth of social media use, the number of user-generated posts is growing exponentially. Social media platforms find it challenging to moderate all these posts before reaching a wider range of audience as these posts are written using multiple languages and using different forms of multimedia and the lack of contextual, linguistic expertise, social and cultural insights for accurate hate speech and fake news identification. Following this necessity, the Social Media Data Analytics group was established in 2019 with funding from the Accelerating Higher Education Expansion and Development (AHEAD) project. The Social Media Data Analytics group of the University Moratuwa proposed **“An Analytical Framework for Digital Social Media in Sri Lanka”** to overcome such challenges when moderating social media content written in Sinhala, Sinhala words written in English and English posts and is currently in the process of achieving the following objectives.

- Identify areas in social media applications that need to be monitored and bring insights and find mechanisms to collect a large volume of data (Big data) from different social media domains and validate their reliability.
- Develop robust data mining solutions which can combine different technologies, data, and social media domains to effectively analyze behaviour and content disseminated through social media.
- Create supportive structures to introduce new policies to social media users and the general public based on the insights of the data analysis.

- Carry out research to transform existing Machine Vision and Natural Language Processing (NLP) solutions to be applied in the Sinhala language context in social media.
- Develop an adaptive and automated framework which can provide a crowdsourced interface to analyze the content and users in social media and provide a more secure and privacy-preserving environment to its all users.

The research team is composed of a multidisciplinary team of researchers from the fields of computer science and engineering, social sciences and legal studies, undergraduate students, postgraduate students and research assistants who work in the areas of Data Mining, Natural Language Processing, Image Processing, Crowdsourcing, User Experience Engineering, etc.

A few contributions from our team members to the existing research community and their impacts are listed below;

Sinhala character recognition: A Sinhala character recognition tool which identifies Sinhala text contents with more than 92% accuracy on images of single-page or double-page documents. This OCR gives better results than most of the existing OCRs such as Google OCR. This is a by-product of our research which supports the identification process of hate content on social media images. This tool can also be used as a Sinhala OCR to recognize Sinhala text images.

Anomalies' content distribution detection:

Anomalies' content propagation detection on social media contents are another output of the ongoing research. Multiple aspects can narrow down the impact of the proposed algorithms. Firstly, the scientists involved in social media research as underlying compendium research can use the algorithm for their outer layers of investigations. Secondly, scientists can configure the proposed algorithm to detect and predict social trends in their research projects. Finally, if a social media company is willing to embed proposed algorithms in their existing algorithms, that would highly impact the societal content trend identification, including social media analysts and researchers.

Nested Named Entity boundary detection:

A novel approach is used for Nested Named Entity boundary detection for Sinhala language considering undesirable religious statements in social media. Experiments reveal that this approach has achieved state-of-art performance over the existing baselines. It is an important aspect in information extraction, information retrieval, event extraction, sentiment analysis etc. On the other hand, spreading undesirable religious statements through social media has become a burden for the wellbeing of society.

Crowdsourcing platform: A crowdsourcing platform was developed to facilitate the identification of inappropriate content using subjective responses from the registered crowd workers limiting the focus to social media content written in Sinhala and Sinhala words written in English letters. During the study, a novel approach was tested using a hate speech corpus generation method, and a user experience measuring technique was introduced to moderate social media contents through crowdsourcing as outcomes of the research. The experimental results demonstrate that it is possible to use criteria in deciding if the content posted on social media is appropriate for their users or not. It is expected that the framework remains useful for those aiming to improve user experience of a software product in which content plays a major role.

Our ongoing research work comprises the following research projects;

- The ranking of hate speech propagators in social media using community-based profiling techniques.
- Performing a latent semantic analysis for architectural embedding to the event-driven architecture, engrossing detective and predictive analysis over adjacent transformation trends over multiplex social networks on a multi-layered, reactive event-driven software architecture for trend detection on multiplex trends.



- Derive a model to detect fake news at an early stage through propagation path classification
- Implementation of a mechanism to determine image posts in social media messages that raise social issues and implementation of a mechanism to identify the key attributes of images to detect the redistribution of images within social media.
- Identification of a best trust metric and to model the trustworthiness of the crowd workers of the crowdsourcing platform. With the use of a well-implemented crowdsourcing platform, it will be possible to find more nuanced patterns with the use of human judgment and filtering and to take preventive measures to create a better cyberspace.

Our Developments:

- Sinhala OCR web application:
<https://drive.google.com/file/d/1-DSPtNeASOO2RoxGJluO3MVR2Z3B6LA1/view?usp=sharing>
- HelaNER: A Novel Approach for Nested Named Entity Boundary Detection:
<https://www.youtube.com/watch?v=rHrQPOW9xPw&t=1s>

Contact Information



<https://uom.lk/research-groups/sma>

OUR PEOPLE

Research Coordinator

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Dr. E.R.A. Perera



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Ms. Ranasinghe, S.



Ms. Chandika, R.



Ms. Lijane, L.



Ms. Shadriska, D.



Mr. Maduranga, H.



Ms. Aranyanga, M.



POTENTIAL OF RARE EARTH ELEMENTS (REE) IN SRI LANKAN ONSHORE AND OFFSHORE TERRAIN AND DEVELOPMENT OF EXTRACTION TECHNIQUES

Rare earth elements (REEs) are critical raw materials that are essential in numerous high-tech and green technologies. With the diversification in applications and the continuously increasing demand for REEs, maintaining a reliable and steady REE supply is challenging as it depends only on the limited primary REE production in the world. Therefore, contribution to the global supply chain of REEs from countries like Sri Lanka is of immense importance to cater to future REE demand.

Due to poor understanding and lack of previous attempts to extract REEs from potential sources in Sri Lanka, exploration of REE potential in different geological formations in Sri Lanka is significant in both local and global context. Therefore, we are a group of researchers (Prof. N.P. Ratnayake, Prof. H.M.R. Premasiri, Prof. P.G.R. Dharmaratne, Dr. A.M.K.B. Abeysinghe, Dr. L.P.S. Rohitha, Dr. D.M.D.O.K. Dissanayake, Dr. I.M.S.K. Ilankoon, Mr. M.N.P. Dushyantha, and Ms. B.D.N.M. Batapola) who focus on investigating the potential of REEs in Sri Lankan resources and developing suitable extraction techniques to extract them in an economical and sustainable way. This research group was established in 2019 and is financially supported by the Accelerating Higher Education and Development (AHEAD) Operation of the Ministry of Higher Education, Sri Lanka funded by the World Bank (AHEAD/DOR/6026-LK/8743-LK).

With a wide range of successful explorations, we identified the Eppawala phosphate deposit and gem mine waste as two potential secondary REE sources in Sri Lanka. Currently, we are developing suitable extraction techniques to recover REEs from the preceding resources.

In addition, we were able to publish research findings in reputed journals (Q1 journals with high impact factors) and are currently compiling a few more manuscripts as well. We firmly believe that the findings of this research project would be of utmost importance for the future developments of REE extraction and processing in Sri Lanka, which will be beneficial to the technological and economic development of the country.

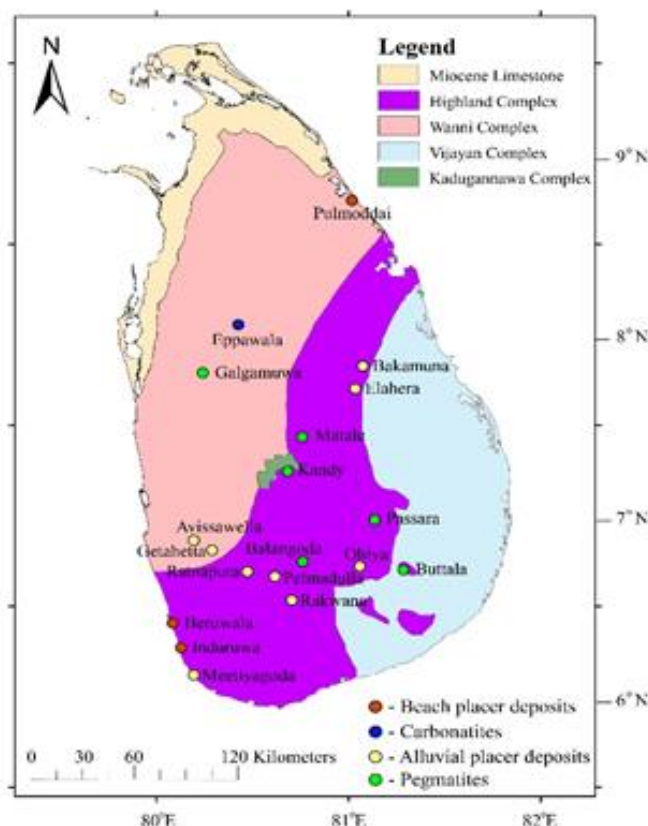


Fig 1: Potential REE sources in Sri Lanka

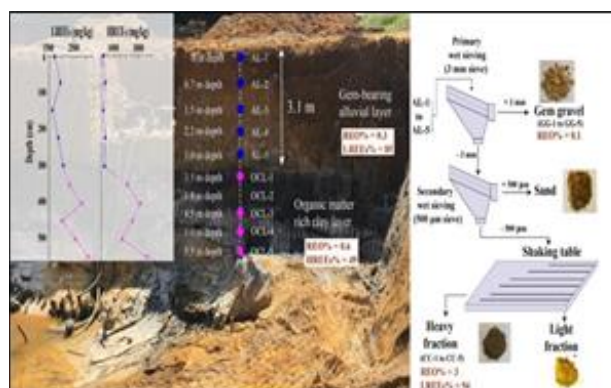


Fig.2: Extraction potential of REEs from gem mining wastes in Sri Lanka

DEVELOPMENT OF INTELLIGENT CAMERAS WITH A REAL-TIME VIDEO ANALYTICS SYSTEM

Profile:

Dr. Ranga Rodrigo, principal investigator:
Dr. Ajith Pasqual, co-investigator
Dr. Jayathu Samarawickrama, co-investigator
Dr. Chamira Edussooriya, co-investigator
Mr. Hasanka Sandujith, industry collaborator
Mr. Hasith Dharmarathna, industry collaborator
Mr. Natheesan Ratnasegar, research engineer
Mr. Kalan Abeywardena, research assistant
Mr. Nadarasar Bahavan, research engineer
Mr. Shechem Sumanthiran, research assistant
Mr. Sanoojan Baliah, research engineer
Mr. Nalith Udugampola, research engineer
Mr. Prarthana Kodithuwakku, project assistant

Funding:

World Bank's AHEAR RIC R2 grant

Objective:

During the last two decades, surveillance cameras (commonly known as CCTV cameras) have moved from being a device used primarily in high security zones to a commoditized product used by a wider spectrum of society to monitor their surroundings – large retail stores, roads, and even homes. Without human operators, the usefulness of CCTV in its current form is questionable in the absence of true analytic processing. This is due to two reasons: first, the servers that receive video streams from hundreds of surveillance cameras do not have the computational capacity to analyze all the streams, the solution being edge processing (in-camera processing); second, deploying successful deep-learning based research work within devices is still a challenge. In this context, we propose to manufacture an intelligent camera (hardware) for edge processing for video analytics that would include a vision Intellectual Property (IP) core of our own.

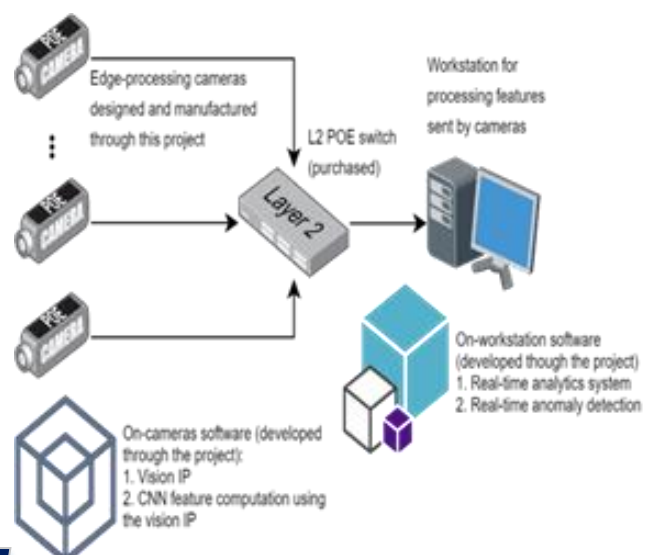
The feed from this camera will be the deep-features suitable for computationally less expensive video analytics in addition to the regular video stream. This needs a specialized real-time video analytics system (the software) that we will have to develop. More importantly, this software will include anomaly detection – detecting events that could be deemed different from normal activities. Collaborating with the industry partner, Paraqum (Pvt.) Ltd., who has experiencing in developing and exporting high-tech electronic products, we will endeavor to sell our camera, IP and software overseas, thus earning foreign exchange.

Items to Be Commercialized through this Project:

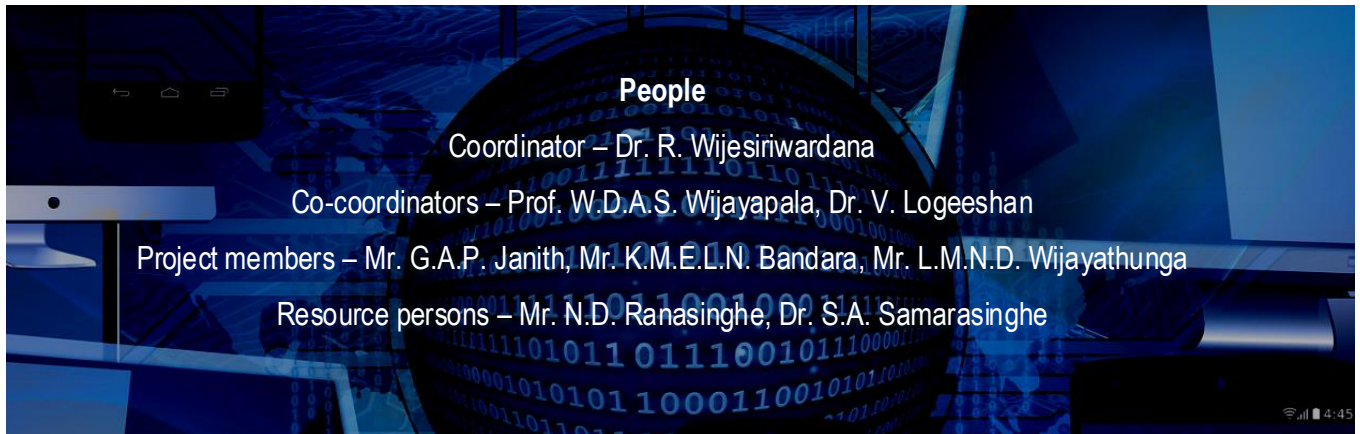
1. Intelligent surveillance camera: production-ready commercializable electronic product
2. Generic vision semiconductor IP core plantable in any embedded vision system (FPGA/ASIC IP)
3. Real-time commercial-grade video analytics software for event and anomaly detection

Contact Information

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MULTIPURPOSE, ENERGY HARVESTING AND HUMAN LIMB MUSCLES PERFORMANCE EVALUATING EXERCISE EQUIPMENT



The project is funded by AHEAD grants.

In this study, a specifically built novel human energy harvesting machine is introduced. The uniqueness of the machine is that it has two flywheel assemblies with two separate DC generators to extract human mechanical energy separately from the upper and lower limbs of the body while giving the rider a full-body workout. The obtained human mechanical energy is stored in lead-acid batteries as electrical energy to power low-power household appliances (~150W). Experimentally, this energy harvesting machine showed a maximum electrical power output over 200W for untrained Sri Lankan university students within the age range of 25 – 30 years.

Furthermore, a physiological parameter monitoring system was designed to monitor the rider's physical condition during the workout. This low-cost, non-invasive, wearable physiological parameter monitoring system consists of two separate real-time sensing units to detect the heart rate and respiratory rate of the rider. The heart rate measuring unit comprises a chest strap and a heart rate transmitter. The respiratory rate measuring unit comprises a plastic face mask that carries a thermistor sensor module.

Additionally, two optical encoders were integrated into the energy harvester to measure the rpm of the upper and lower limbs pedals. A Qt-based real-time Graphical User Interface (GUI) was developed and integrated to the machine. The rider's lower and upper limbs' power, total power, generated electrical energy and physiological parameters (heart rate, and respiration rate) are indicated in the GUI.

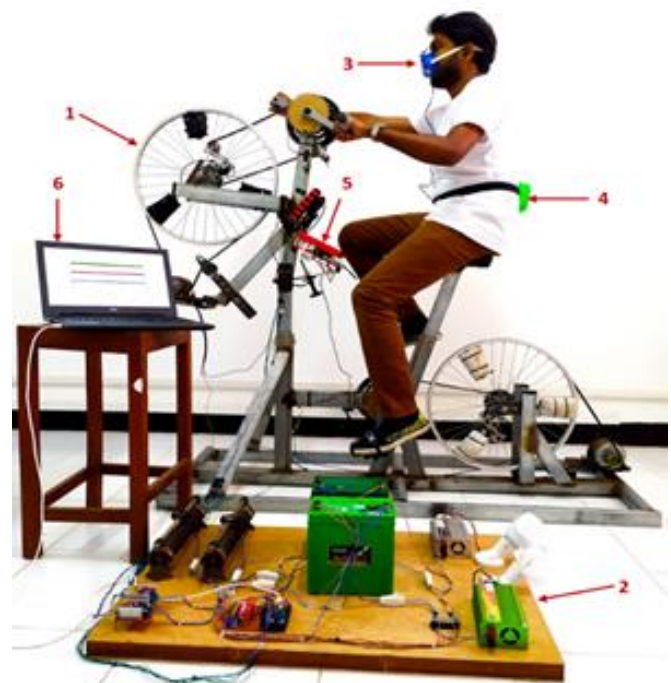


Figure. Overall system of the energy harvester

- (1) Energy harvester mechanical system
 - (2) Electrical system
 - (3) Respiratory rate sensing unit
 - (4) Heart rate and respiratory rate wireless transmitter
 - (5) Graphical User Interface
 - (6) Notebook computer
- (Used only for program debugging and data processing).

OUR RESEARCHERS



One of the key assets of University of Moratuwa is our researchers. The University offers three research degrees, Master of Science (MSc, with a major component of research), Master of Philosophy (MPhil.) and Doctor of Philosophy (PhD.) through its Architecture, Business, Engineering, IT and Medicine Faculties. The annual enrollment to our research programs has significantly increased over the past years. During the period between 2015-2021, more than 700 students have been registered under FGS to read for Research Degrees.

OUR RESEARCHERS



PHD RESEARCH STUDIES

INCLUSIVITY OF MARGINALISED COMMUNITIES DURING THE POST-DISASTER PHASE IN SRI LANKA

A.P.K.D. Mendis

Department of Building Economics

Supervisor (s)- Dr. (Mrs) Menaha Thayaparan

Associate Prof. (Mrs) Yamuna Kaluarachchi



Natural disasters take a disproportionate toll on affected populations, often with the most marginalised bearing the greatest. While the international community has adopted the ideals of resilience and inclusion, in reality, marginalised communities are usually overlooked in post-disaster management. The breadth of the current community protection system is very limited and the existing system does not adapt adequately to the real needs of marginalised communities in the post-disaster context in Sri Lanka. There is a dearth of literature on the engagement of such communities in Sri Lanka. Thus, this study aims at enhancing the inclusivity of this group.

Currently, a systematic review on the challenges faced by marginalised communities in the post-disaster context is being carried out using the PRISMA methodology. It will further strengthen focusing on the Sri Lankan context through a questionnaire survey in future. Through a desk study, the policies and frameworks related to disaster management were explored in order to identify the inclusion of these communities. The extent to which these policies and frameworks have been adhered to in the decision-making process will be investigated to identify gaps between policies and practices. In addition, this research intends to develop a stakeholder mapping to understand stakeholder engagement with marginalised communities and to propose strategies to minimise such gaps and to enhance the inclusivity of these communities during the post-disaster phase.

FORMULATION OF AN ASSESSMENT MODEL TO EVALUATE USER PHYSICAL SAFETY AND COMFORT IN URBAN PUBLIC STREETS: A CASE STUDY OF COLOMBO CITY

Ahranyakumari Kumaraguruparan

Department of Architecture

Supervisor (s)- Dr. Janaka Wijesundara

Dr. U.G.D. Weerasinghe

Dr. M.F.M. Firdhous



Streets are major connectors of urban spaces frequently accessed by a large population every day. The safety and comfort of such streets determine the willingness of people to use these spaces. Increasing urbanization and urban population, with lack of efficient infrastructure planning had led to congestion and high numbers of traffic accidents. In order to overcome such situations, substantial research has been carried out to establish psychological and social quality assessment models. However, none of these address the scoring of physical safety and comfort to understand the existing state of the streets. Therefore, this research involves: identifying the urban public street categories, the vital elements determining their physical safety and comfort, and relevant standards from local, regional, and international best practices. An assessment model to determine the extent of overall physical safety and comfort of existing urban public streets of Sri Lanka shall be established based on the findings. The model shall be formulated to provide a quantitative score validated through expert feedback and application at case studies at public streets in Colombo for each identified category. This model is intended to aid the remodeling of urban public streets in Sri Lanka, to reduce the identified physical vulnerabilities and discomfort.

IMPROVE BUILDABILITY THROUGH PROCUREMENT METHODS TO ENHANCE CONSTRUCTION PROJECT PERFORMANCE

P.L.I. Wimalaratne

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A construction project is commonly acknowledged as a successful project when the aim of the project is achieved in terms of predetermined objectives of completing the project on time, within budget, and to the required quality standard. However, in most construction projects severe time and cost overruns, issues relate to poor quality are common.

The root causes of these issues have been identified as poor cost estimation, lack of design integration, extensive number of change orders, poor selection of procurement method, and lack of buildability. Among these causes, lack of buildability has been identified as a key factor that even directly or indirectly impacts on the other issues as well. This is because buildability impacts throughout the construction projects, starting from conceptual planning, throughout the procurement processes, and also involving stakeholders in the decision-making to achieve their satisfaction.

There is a growing awareness that the lingering underperformance of the construction sector can be moderated and potentially prevented through revisions in operations and strategies associated with procurement method. Even though buildability can be improved through appropriate procurement methods, this has not been adequately explored. Hence this research focuses on incorporating buildability into procurement methods to improve project performance in the construction industry.

DEVELOPMENT OF A LEGAL AND REGULATORY FRAMEWORK FOR ENTERTAINING UNSOLICITED PROPOSALS TOWARDS SUCCESSFUL IMPLEMENTATION OF PPPS IN SRI LANKA

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Dr. Chandanie Hadiwattege



Governments around the world have sought to involve the private sector in the delivery of public services that have customarily been within the public authorities' domain through alternatives. Public Private Partnership (PPP) is one of such alternatives. According to the recent years' budget speeches and annual reports of central bank of Sri Lanka, it was revealed that to fill the investment gap, the private sector was being encouraged to invest in infrastructure development activities and other related projects through PPPs programmes. Lack of well-established legal and regulatory framework has been identified as one of key challenges among implementing PPPs even in Sri Lanka. In practice, PPP projects can be initiated through either solicited and unsolicited approach. Recent years, the adoption of unsolicited PPP proposals has increased tremendously in both developing and developed countries since it taps the unique ideas and innovations of the private sector. Sri Lanka has a track record of accepting PPPs through unsolicited proposals. The Sri Lankan government has implemented several mechanisms to accept unsolicited proposals from time to time, including direct negotiation, competitive tendering, the Swiss challenge method, and various institutional frameworks to deal with such PPPs. Due to deficiencies in the existing PPP legal and regulatory environment for unsolicited proposals, it has been reported that several government institutes have adopted various methods to entertain unsolicited proposals. Thus, this study attempts to identify how existing legal and regulatory framework should be reformed to successfully launch PPPs by unsolicited proposals in Sri Lanka.

UNVEILING THE ENERGY CULTURE ROADMAP FOR ENERGY-RELATED IMPROVEMENTS IN THE TEXTILE AND APPAREL INDUSTRY

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Dr. Gayani Karunasena

Dr. Nateque Mahmood



The Paris Agreement aims to limit global warming to 1.5 degrees Celsius, compared to the global temperature at the pre-industrial levels. Global energy consumption has been the main contributor to global warming due to the associated Green House Gas (GHG) emissions. However, as per today's progress, energy-related improvements are far from the target of reducing absolute emissions. Despite the great progress in renewable energy, it has not effectively replaced fossil fuels. On the other hand, the global rate of energy efficiency improvement is also far behind the expected annual progress by the Sustainable Development Goal 7. Overall, the current behind the curve progression of the global energy-related improvements stresses the need for alternative approaches to look at the issue. Further, traditional techno-economic thinking has been identified as a significant reason for this paradoxical situation. Therefore, this research brings the novel energy culture approach to the problem in a promising way. The study aims to explore a road map for energy culture enhancement that supports more uptake of the energy-related improvements in the textile and apparel industry since this industry has been a major energy-consuming industry in Sri Lanka. The study employs a qualitative research approach that includes 15 expert interviews, 3 focus groups and 4 case studies. The findings will inform the energy culture research with the proposed energy culture framework and the industry with the potential applications of the framework to enhance the energy culture of the individual organisations. At large, the energy-related policy organisations shall utilise the proposed framework for monitoring and supporting the energy-related improvements in the Textile and Apparel industry.

MULTI-OBJECTIVE APPROACH FOR SIZING, ENERGY MANAGEMENT AND CONTROL OF DC MICROGRIDS WITH BATTERY STATE OF CHARGE REGULATION

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Recently, greenhouse gas emissions have become a significant concern due to the accelerated consumption of fossil fuels and the growing electricity demand. DC microgrids (DCMGs) with renewable energy sources (RESs) have become popular as the world is looking for cleaner solutions, the advanced growth of power electronic devices and the rapid increase of modern DC loads. However, the major drawback of this technology is the intermittency nature and undesirable transients due to rapid fluctuations in RESs. Maintaining a reliable and safe power supply is crucial in any country; therefore, MG power and energy management are essential. When it comes to stand-alone operation in DCMGs, intermittency issues become even a greater challenge since there is no grid intervention to absorb those sudden fluctuations. In this aspect, hybrid energy systems such as batteries and supercapacitors, batteries and diesel generators indicate a more capable solution that comprises better combinations of high-energy and high-power density. Hybrid energy systems sum up the highest equipment cost; on the other hand, designers frequently overestimate system capacities to ensure system reliability and suffer an unnecessary higher investment cost. Therefore, the optimal sizing of DCMG and a better energy management strategy for a smooth operation in DCMGs are crucial. This research is focused on developing a novel multi-objective optimal sizing and energy management strategy for a stand-alone DCMG consisting of a solar PV system, wind power system, battery storage, and load demand with other alternatives such as supercapacitors and diesel generators.

DEVELOPMENT OF A MATHEMATICAL MODEL TO PREDICT THE GROWTH AND ACCUMULATION OF HIGH VALUE COMPOUNDS IN MICROALGAE

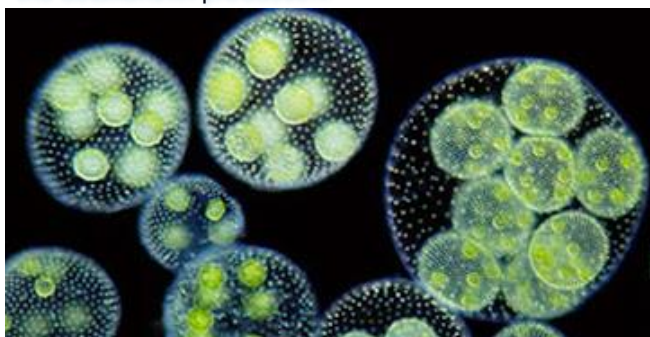
Vinoj Chamilka Liyanaarachchi

Department of Chemical and Process Engineering

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Prof. R. A. Attalage

Microalgae are photosynthetic microorganisms with the ability to synthesize a number of bioactive compounds including carotenoids, lipids, proteins, and vitamins. Hence, they are employed in numerous applications in pharmaceutical, nutraceutical and cosmeceutical industries. Among carotenoids, astaxanthin has a high antioxidant capacity, which assists in protecting cells from oxidative damage. The microalga *Haematococcus pluvialis* has been identified as the richest source of natural astaxanthin and has been approved for human consumption by the Food and Drug Administration. The growth of *H. pluvialis* depends on environmental parameters and nutrient availability. However, the effect of these parameters on the growth of the species is difficult to interpret due to the complexity of biological systems. Mathematical modelling techniques can be used to simulate the dynamic production of bioactive compounds in microalgae due to their capability of integrating non-linear systems. In this study, the impact of environmental parameters and nutrients on the growth and astaxanthin accumulation of *H. pluvialis* was identified through experiments and mathematical modeling. Two artificial neural network models were developed to predict biomass concentration and astaxanthin content using experimental data. Results showed that high biomass concentration can be achieved by employing higher light intensities, and moderate nitrogen and phosphate concentrations. The highest astaxanthin content of 3.00 % w/w could be observed at the higher light intensity, lower nitrate concentration and phosphate concentration within 7 days of cultivation. Currently, a metabolic model of *H. pluvialis* is being developed to predict the biosynthesis pathway of astaxanthin production, to further optimize the astaxanthin production.



SUSTAINABLE CULTIVATION OF MICROALGAE AS FEEDSTOCK FOR BIOREFINERIES

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Microalgae are unicellular photosynthetic organisms found in freshwater and marine eco-systems. Due to their ability of synthesizing commercially valuable metabolites such as pigments, lipids, and carbohydrates, microalgae are considered as a potential feedstock for the production of pharmaceuticals/nutraceuticals, food/feed and biofuels, among other products. Microalgae have higher growth rates and photosynthetic efficiency compared to other biological feedstock, making them an attractive alternative feedstock for sustainable bio-based industries. Moreover, microalgae do not require potable water and arable land for their growth.

Due to the ability of simultaneously synthesizing diverse metabolites, microalgae are considered as a potential feedstock for biorefineries. The main aim of such biorefineries is to increase the product spectrum to obtain economic benefits. Nonetheless, the practical implementation of microalgae-based biorefineries is challenged by the high water demand and nutritional requirement. These challenges could be overcome through the utilization of wastewater and seawater as alternative growth media. Freshwater microalgae species can be cultivated in wastewater with or without dilution, whereas marine species require wastewater-seawater mixed media for their growth. Employment of wastewater as a growth media provides the added benefit of wastewater phycoremediation simultaneous to the production of valuable biorefinery feedstock, contributing to the circular economy while enhancing the overall sustainability of the process.

UTILIZATION OF DEMOLISHED CONCRETE WASTE FOR ROLLER COMPACTED CONCRETE PAVEMENT APPLICATIONS

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Roller Compacted Concrete Pavement (RCCP) is a type of zero slump concrete product, which has renewed the interest of sustainable pavement designers with its potential to reduce the total cementitious material content of concrete mix. RCC is produced with the same ingredients as in conventional concrete paving, but with different proportions determined by a suitable mix design approach. RCCP construction procedure is similar to that of asphalt paving, where laying is performed using a modified asphalt paver, and steel drum rollers follow the paver to ensure that the laid RCC mix is compacted to its desired density.

Even though concrete pavements are durable in the norm, owing to poor construction practices and improper maintenance, the concrete surfacing of low volume roads is at a stage needing rehabilitation. The current rehabilitation practice regarding damaged concrete roads in Sri Lanka is replacing the damaged pavement with a new surfacing, where the deteriorated concrete layer is removed as a landfill material or sometimes reused as a base for the new surfacing. However, full disposal of the damaged pavement and subsequent replacement with a new pavement is not an economically viable construction practice. The objective of this research is to evaluate the applicability of deteriorated concrete pavement for the reconstruction of new pavement in an economical and sustainable approach. Meanwhile, the RCC mix design optimizations will be pointed out from this study to improve the strength properties of RCC.

AN ASSESSMENT OF THE THERMAL PERFORMANCE OF EPS BASED LIGHTWEIGHT CONCRETE PANEL BASED MULTI-STORY HOUSES IN TEMPERATE CLIMATES

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Prof. Tim Ibell

Dr. Andrew Shea



Enhancing thermal performance is vital, as it will contribute considerably to the reduction of energy consumption of a building. In the temperate climate zone, maintaining the indoor climate with active and passive techniques is a must due to extreme outdoor conditions, and hence, stringent building regulations are laid aiming to meet the energy conservation goals. much research has been conducted to find optimum solutions for buildings with enhanced thermal performance. In this regard, the development of the building envelope is considered as an effective passive technique. Currently, there is a major trend involving using alternative building materials such as light weight construction panels rather than traditional building construction materials such as cement blocks or bricks for the building envelope. The reason is that it provides many benefits ranging from minimizing the use of natural resources to ease of construction. In Sri Lanka, such lightweight wall panels were adopted by the Department of Civil Engineering, University of Moratuwa under the guidance of Professor M.T.R. Jayasinghe, and Professor C Jayasinghe of the same department. It was proved that this EPS based lightweight concrete wall construction effectively acts as load bearing walls of single story and two storied houses. However, the thermal or hygric performances of houses constructed with EPS based concrete panels have not yet been studied. Under this research, it is expected to examine and improve the thermal performance of various houses made with these panels. In this regard special attention is given to the temperate climatic condition.

FACTORS AFFECTING THE CAREER ADVANCEMENT OF SRI LANKAN WOMEN ENGINEERS

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Dr. Wasanthi Madurapperuma



It is no surprise that there is a shortage of women engineers. The reasons for the shortage have been researched and discussed in many studies, and suggestions for improvement continue to evolve. However, there are few studies that have specifically identified the positive aspects that attract women to engineering and keep them actively engaged in the field. This study examines how women engineers view their education, their work, their motivation to remain in the field and achieve professional success in the Sri Lankan industrial sector. Hence, this proposed systematic academic study will contribute to the enhancement of the theoretical and empirical knowledge on the professional success of women engineers in Sri Lanka. Suitability of the engineering work environment, challenges faced in the engineering field that affect family responsibilities and Sri Lankan cultural factors are examined through this research study in terms of the manner in which they affect women engineers in Sri Lanka.

The researcher has planned to carry out this study qualitatively. Therefore, the constructionist grounded theory approach will be used to design the study. Women engineers from various engineering disciplines in top management positions in the Sri Lankan industrial sector will be selected for data gathering as per purposive and theoretical sampling strategies. Semi-structured face to face interviews will be held with selected women engineers to collect data.

The outcomes of this study will be a source of guidance and motivation for young women engineers to achieve professional success.

ENGINEERING ETHICS & ENTREPRENEURSHIP; IMPLICATIONS ON BEHAVIOR & PERFORMANCE OF TECHNOLOGICAL ENTREPRENEURS IN SRI LANKA

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Prof. S.W.S.B. Dasanayaka



Today, many innovative-minded engineers in Sri Lanka and the international context have become successful technology entrepreneurs. Thus, a tremendous responsibility lies upon these engineers for behaving and performing ethically in today's competitive business world. However, being professionally ethical does not always give positive results in business. Entrepreneurial professional engineers cannot neglect Engineering Ethics and perform entirely as pure business managers. The research literature does not contain sufficient evidence of such investigations within Sri Lanka and the international context. Hence, this study was designed to explore ethical practices of techno-entrepreneurial engineers, focusing on Chartered Engineers in the Sri Lankan industrial sector as a grounded theory study. Data were collected from the purposefully and theoretically selected sample of entrepreneurial engineers by conducting face to face interviews utilising semi-structured open-ended questions. Interviews were voice recorded with the consent of the participants and transcribed verbatim to analyse using constructivist grounded theory techniques. Further to the interviews, a careful study was conducted on the company websites of each entrepreneur engineer to verify the findings. Analysis has revealed theoretically and practically significant findings on the accomplishment of Engineering Ethics and its implications on entrepreneurial behaviour & performance. The findings of this interdisciplinary study which connects management, social sciences and engineering, has already been disseminated to society through high-quality scholarly publications. Business-minded engineers and other professionals can reap the benefits of these findings by incorporating such ethical practices in their entrepreneurial journey while knowing the implications.

IMPACT OF ABSORPTIVE CAPACITY AND CUSTOMER CENTRICITY ON OPEN INNOVATION IN TECH-STARTUPS

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Dr. G.D. Samarasinghe



Tech-startups are vital entities in the business context which contribute to the economic and social aspects of the country, but most of them tend to fail within the first five years of operation. Hence, this study focused on developing a conceptual model, collaboratively combining customer centricity practices and absorptive capacity towards value creation and value capture in an open innovation perspective which leads to achieving a sustainable competitive advantage. This will be the first study which addresses the value perspective of open innovation in the Sri Lankan context and will identify the challenges as well as avenues to uplift the open innovative performance while creating and capturing value. Also, the study will produce new knowledge on value co-creation in open innovation which is only marginally addressed in open innovation literature. Moreover, this new knowledge in value co-creation in open innovation shall be generated through the lens of the dynamic capability approach by combining both organizational aspects as well as customer centricity while improving understanding and expanding the contribution of Chesbrough et al., (2018) as it relates to value processes in open innovation. Finally, the study will develop and validate a conceptual model (framework) by combining customer centricity practices, absorptive capacity and value co-creation in open innovation perspectives to achieve a sustainable competitive advantage which can reduce failure rates in Sri Lankan tech-startups through theoretical and empirical implications.



SPATIO-TEMPORAL ADAPTATION OF THE MAC LAYER FOR MESSAGE PRIORITIZATION IN IEEE 802.11P VEHICULAR NETWORKS

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Recent road traffic statistics show a drastic increase in fatal and non-fatal road crashes. It highlights the urgent requirement to examine the dire situation of road accidents and take appropriate action. The intelligent transportation system (ITS) supports the delivery of safer, more efficient, and sustainable transport solutions using advanced communication technologies. One such promising vehicular wireless communication technology is DSRC/WAVE. Broadcasting of Basic Safety Messages (BSMs) to neighbors over the IEEE802.11p Medium Access Control (MAC) layer is the core function of DSRC communication. MAC adopts IEEE802.11e mechanism for Quality of Service (QoS) enhancement with four Access Categories (ACs) for message prioritization according to the degree of emergency.

Many studies prove that in high vehicular and communication traffic densities, BSM dissemination among vehicles experiences delays and losses due to contention among the participating vehicles, which deteriorates performance. As a result, many MAC protocols have been developed to improve the performance of BSM dissemination on different vehicular contexts. However, this type of channel access method still faces challenges in effectively gaining medium access for BSM dissemination. This study also aims to analyze such limitations in BSM dissemination using theoretical and simulation techniques to develop a strategy for adapting MAC layer parameters for BSM dissemination based on the spatio-temporal dynamics of vehicular networks. Also, performance metrics; packet delivery ratio, throughput will be evaluated in real-time scenarios using intensive simulation. The proposed protocol will also be compared to other existing protocols, with the results of the simulation being used to improve the proposed protocol.

ESTIMATION OF THE COST-OF ENERGY-NOT-SERVED FOR SRI LANKA USING A NOVEL HYBRID APPROACH

W.A.K.W. Weerasinghe

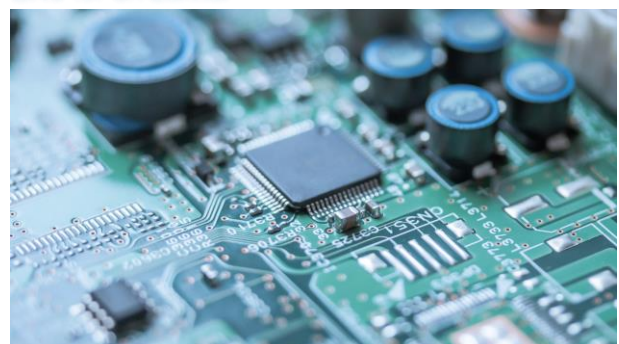
Department of Electrical Engineering

Supervisor (s)-Dr. S.K. Abeygunawardane

Cost of Energy Not Served (ENS) provides an economic value to the losses incurred due to electricity interruptions. It is an important parameter used in medium-term/long term generation and transmission planning, technological up-gradation of assets (e.g.: smart grid technologies), design of regulatory incentives and compensation mechanisms, etc. As the cost of ENS affects many management decisions made on power systems, updating this figure is vital.

Three main methods of assessing the cost of ENS are indirect analytical methods, customer surveys and case studies. Out of these three, the survey based method is most preferred and extensively used due to its ability to provide more accurate and customer-specific data for the study. Two survey-based studies have been conducted within the past two decades to assess the cost of ENS in Sri Lanka. However, survey-based studies do not link the cost of ENS with socio-economic indicators and therefore, the cost of ENS figure cannot be updated.

This research proposes a novel hybrid approach to obtain the cost of ENS by combining customer surveys and analytical methods. The contingent valuation survey approach is used for the residential sector, whereas the direct worth approach is used for industrial and commercial sector surveys to collect more accurate and customer-specific data. In addition, this proposed approach considers the relationships of socio-economic parameters with the cost of ENS in order to update the estimated cost of ENS figures. The proposed approach will be used to estimate the cost of ENS for Sri Lanka.



IMPACT OF URBAN VEGETATION CONFIGURATIONS ON MICROCLIMATE AND OUTDOOR THERMAL COMFORT IN WARM - HUMID COLOMBO

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Integration of greenery into the urban landscape is a well-established strategy for urban climate mitigation and adaptation. However, malfunctioned and defective urban vegetation in urban landscapes in terms of urban heat mitigation are dominant in many developing countries in the tropics due to the lack of a scientific basis of for tree selection, location, and configuration. This should be addressed in terms of improving urban microclimate to create a comfortable environment for urbanites. Therefore, this study intends to scientifically determine the urban vegetation configuration strategies for climatically responsive urban design. Thus, the study aims to investigate the impact of diverse vegetation configurations on urban microclimate and thermal comfort with varying urban morphologies to improve perceived comfort and the efficiency of using urban spaces in warm-humid Colombo. The objectives are; to identify key vegetation parameters relevant to urban morphology in tropical cities, to empirically determine the cooling effects of selected vegetation parameters, and to propose ideal vegetation configurations and patterns to improve microclimate OTC in different urban morphologies in Colombo.

The proposed methodology comprises three phases; field measurements, numerical simulation modelling, and scenario development for OTC improvement. Thermal comfort will be estimated using “ENVI-met 4.0 Bio met” simulations employing physiologically equivalent temperature (PET). Results of this research ensure the capability of improving evidence-based recommendations and design guidelines for the reference of policy-makers to enhance outdoor thermal comfort and understanding gaps for further research in terms of urban vegetation.

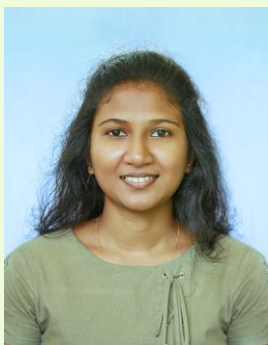


FEASIBILITY ASSESSMENT OF GREEN WALL IMPLEMENTATION IN THE TROPICAL CLIMATE: A MULTI CRITERIA-BASED APPROACH

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Most parts of the world have moved towards the adaptation of the green wall concept to mitigate the excessive energy consumption in urbanized areas and negative environmental impacts of the building sector because green walls are an environmentally friendly and energy-efficient sustainable solution that can increase the natural vegetation density in dense urban areas. Though Sri Lanka is facing an energy crisis as well as a depletion of natural vegetation, which has resulted in building designers seeking effective ways to balance the natural ecosystems with the building constructions, the use of the green wall concept is still in its infancy stage in the Sri Lankan context. In the local as well as international contexts, poor public perception and awareness about the green wall technology and its benefits have become the major hindrance to adapting and spreading the concept of the green wall. Thus, this motivates the requirement of an in-depth assessment of green wall application.

The outcome of the research is expected to promote both practitioners as well as academics by providing knowledge on the application of green walling as a green technology for new as well as existing buildings, costs and saving information of green technologies, and barriers and challenges in transforming existing buildings into sustainable buildings. Further, the outcome of the research can be particularly used by sustainability authorities such as Green Building Council Sri Lanka (GBCSL), Sri Lanka Sustainable Energy Authority (SLSEA), to improve the existing rating systems and guidelines.

EVALUATION OF OPTIMUM SOLUTIONS FOR MATERIAL RECOVERY IN MUNICIPAL SOLID WASTE OF SRI LANKA IN CIRCULAR ECONOMIC FRAMEWORK

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Dr Mayuri Wijesundara



Sustainable waste management is a prerequisite for all societies today to protect the environment and human health. The environmental burden caused by high waste generation rates should be effectively dealt with since the link between economic growth and waste should be broken and decoupling should be achieved. Furthermore, it is necessary to focus on basic and applied research to find the best ways and solutions to promote the recovery of the generated waste materials from several sources by manufacturing new products with high added value or producing energy. Research and technology have the power to identify additional innovative ways to make efficient use of the value hidden within the different waste streams generated and expand the life cycle of goods and products with multi-side positive effects.

This study focuses on waste material recovery potential in the municipal solid waste in Sri Lanka as a typical developing country. The research results will facilitate the identification of the potential in terms of recovery of material in municipal solid waste in a circular economy framework. Further, the study will promote the development of material recovery options and contribute to future research in terms of finding solutions for mismanaged waste in the household waste material chain. The results are expected to be useful for authorities for careful planning of the waste management policy framework. Further it is intended to stimulate the interest of scientists, industries, and associations and inform them about creating economic and environmental value through collaborative movement towards a near-zero waste society.

FACTOR ASSESSMENT FOR INDUSTRIAL SYMBIOSIS IN SRI LANKA

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Most industries in the country generate a considerable amount of waste which is either open dumped or disposed without due consideration of the environment and ecosystem. The haphazard disposal of untreated waste is growing into a major problem in the country due to the high cost of treatment for industries, lack of infrastructure for industrial waste management, ineffective enforcement of environmental regulations and insufficient capacity for waste management of local authorities. Industrial symbiosis, which is the reuse of waste from one company as raw material by another, has been applied globally with recognized environmental, economic, and social benefits. However, the potential for industrial symbiosis is not exhausted in existing cases, and there is still a wide range of opportunities for its application. This research develops a conceptual waste exchange networking model to implement industrial symbiosis as applicable to the Sri Lankan context and validates the model with a preliminary assessment conducted on waste streams of the textile and apparels industrial sector. Further, this research highlights challenges in industrial symbiosis implementation. The results of this research provides inputs for stakeholders and policymakers on waste management. This study will provide several future research directions in applying a similar framework to assess the feasibility of waste to resource exchanges and industrial symbiosis opportunities for clustered industries or industrial parks.



CAST COMPOSITE DEVELOPMENT FOR FRACTURE IMMOBILIZATION: AN ALTERNATIVE TO PLASTER AND FIBREGLASS CASTS

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Dr. TGPL Weerasinghe

Dr. TP Miyanawala



In modern-day orthopedics, fracture immobilization is conventionally treated with plaster and fiberglass casts. Synthetic cast material encompasses advantages such as superior strength, water-resistance and lightweight in comparison to traditional plaster. However, plaster is still the material of choice in many countries due to its availability, ease in application and removal, better conformity to body contours, low irritation and cost-effectiveness. Hence, there is an imminent need to improve plaster casts to comprise adequate mechanical properties with improved patient comfort, to be sustainable, non-toxic and to maintain the vitality of surrounding skin and soft tissues.

Economical and sustainable agricultural waste products which are known for their pozzolanic activity, improvement of porosity and providing excellent thermal insulation and mechanical strength enhancement can be used as additives to improve plaster casts. This study aims to develop a plaster composite incorporating economical and sustainable agricultural waste material such as rice husk ash and bagasse ash and emerging materials such as Graphene Oxide, to provide better patient comfort, light weight, and enhanced mechanical strength. Mechanical testing along with Finite Element Modelling (FEM) will be used to determine the mechanical characteristics and suitability of the developed composite. The outcomes of this study will be used to develop an economically feasible modification to existing orthopedic plaster suitable for long term immobilization. This can mainly benefit the orthopedic fracture management in Sri Lanka and other countries.

IMPROVING DYEING PROPERTIES OF COTTON FABRICS NATURAL DYES WITH NANOTECHNOLOGY

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Department of Textile and Apparel Technology

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Dr. N.D. Wanasekara

Prof. C.A.N. Fernando

Natural dyes have attracted much attention among researchers in the realm of sustainable dyeing and finishing textiles. The majority of natural dye matter extracted from plant sources such as roots, berries, bark, leaves, and wood. Natural dyes are less toxic, less polluting and less hazardous to health. However, natural dyes have less dye affinity and poor fastness properties with cotton fabric. These problems can be overcome by using chemicals called mordants. Mordants are metallic salts and commonly used alum, ferrous sulfate, copper sulfate, chrome, and stannous chloride like chemicals. These chemicals act as mordants by fixing themselves on the fiber and also combine with the natural dye molecules. However, the metallic mordants are categorized as heavy metals and the use of these chemicals during natural dyeing often raises questions regarding their eco-friendliness. Therefore, remove the disadvantage of metallic salts with natural dying process can be removed by using nanotechnology. Nanotechnology is concerned with materials whose structures exhibit significantly novel and improved physical and biological properties and functionality due to their nanoscaled size. Nanoparticles can provide high dye uptake for cotton fabrics because they have a large surface area-to-volume ratio and high surface energy. These can be synthesized in different methods and several nanoparticles can be used to improve the dye affinity with cotton fabrics. This research investigates the use of eco-friendly and nontoxic type nanoparticles for improving the dyeing properties of cotton fabrics using natural dyes.

STABILIZATION OF SOIL WITH PLASTIC WASTE AND NATURAL LEAF ASH IN SRI LANKA

V.Yathushan

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Supervisor (s)- Prof. U.G.A. Puswewala



Construction of infrastructure on weak or unimproved soil has become critical around the world since it leads to unrecoverable losses. Hence it is imperative to improve the quality of soils conducive to the construction of infrastructure. Currently, available alternatives such as geotextiles and cement stabilization are not cost-effective solutions. Hence this study investigates the effectiveness of using waste plastic, banana leaf ash, bamboo leaf ash and a mixture of ashes of pozzolanic leaves as soil stabilizing agents for three different types of soils. Stabilizing ability is decided based on improved shear strength parameters, Maximum Dry Density (MDD), California Bearing Ratio (CBR) and Atterberg limits (only for ashes) from direct shear, modified proctor compaction, 4 days soaked CBR and Atterberg limits tests respectively on the selected soils. Plastics are mixed with five different weight percentages (0.5%, 1%, 2%, 4% and 8%) and four aspect ratios (1, 2, 3, 4) while ashes are mixed with five different weight percentages (2%, 4%, 6%, 8%, 10%) with the selected soils to investigate their stabilizing potentials. No studies in the past had compared the effects of different types of stabilizing agents on the same soil and the stabilizing ability of a stabilizing agent on different soils. Hence this study will overcome these research gaps.



A FRAMEWORK FOR CRITICAL INFRASTRUCTURE MANAGEMENT WITH A FOCUS ON DISASTERS: A CASE STUDY APPROACH

P.L.A.I. Shehara

Department of Civil Engineering

Supervisor (s)- Dr. G.S.A. Siriwardana



Damage to human lives and critical infrastructure triggering as a result of natural hazards increases each year all over the world. Initiatives are implemented with the intention of decreasing disaster impacts through Disaster Risk Reduction concepts. The significance of Critical Infrastructure and therefore the essential need to enhance their level of resilience capacity is recognized by the Sendai Framework for Disaster Risk Reduction 2015-2030. Furthermore, the Sustainable Development Goal 09 which calls for building resilient infrastructure and promoting more sustainable development also relates to the objective of enhancing resilience capacity. Accordingly, strengthening the resilience capacity of Critical Infrastructures with integration of Disaster Risk Reduction strategies emerge as an urgent necessity in global perspective. Under this emphasis, policy level frameworks and strategies have developed in many of the developed countries. Sri Lanka as a country which is deadly prone to frequent disasters such as floods, landslides and heavy winds, needs developing and implementing such resilient frameworks for Critical Infrastructures. The main objective under this research study is to develop a quantitative framework integrating the Disaster Risk Reduction strategies in Critical Infrastructure management. The framework development is concerned with the narrow focus on Transportation Infrastructure sector in Sri Lanka. Further, this transportation infrastructure framework is mainly developed with the integration of community resilience aspects, organizational resilience aspects and infrastructure resilience aspects in facing the disasters.

REAL TIME ADAPTIVE MACHINE LEARNING FOR CREDIT CARD FRAUD DETECTION

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Dr. Amal Shehan Perera



Fraudulent credit card purchases take place regularly in today's world, resulting in massive financial losses. Detection of credit card fraud involves challenges; namely, class imbalance: that are real transactions that far outnumber frauds, concept drift: that is the habits of customers evolve and fraudsters change their strategies over time, and latency of verification: that is only a small set of transactions are checked by investigators in a timely manner. Real-time adaptive machine learning uses reinforcement learning, where the algorithm communicates consistently with its surroundings to optimize its reward with continuous real-time data sequences and adaptive learning from a small sample size. Thus, real-time credit card fraud monitoring may be used. This research would concentrate on developing a prototype to accurately diagnose extremely sensitive and specific credit card fraud. In the presence of a very limited percentage of purchases, this analysis will address how to handle the class imbalance, how to handle the emergence of data sources due to change in purchasing activity, and how to integrate external information into the fraud detection mechanism to enhance efficiency.



M.SC. RESEARCH STUDIES

A DIGITALLY ENHANCED DISASTER PREPAREDNESS APPROACH TO NATURAL DISASTERS IN SRI LANKA

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While disasters disproportionately affect developing countries compared to higher-income countries, developing countries lack significant preparedness at all levels mainly due to financial, socio-economic and cultural challenges. Studies strongly suggest that one of the key reasons for this low level of preparedness is that the governments continue to adopt traditional disaster preparedness approaches instead of including digital innovations in which provide opportunities to resolve existing challenges and build up a robust preparedness system to effectively respond and recover from forthcoming disasters.

Sri Lanka which was deeply affected by a series of disasters in the past decades and faces considerable probability of future disasters endeavours to overcome this vulnerability through a wide-ranging preparedness approach. However, as a developing country, it still maintains a lower level of disaster preparedness due to a range of sociological, economic, physical, political and cultural gaps in the current disaster preparedness approaches. According to the latest update of the United Nations Office for Disaster Risk Reduction in 2019, the lack of early warning dissemination at local levels, slow response, lack of community preparedness and lack of coordination and information management between stakeholders have been identified as the major challenges in current preparedness approaches in the Sri Lankan context. Hence, it is vital to develop digitally enhanced disaster preparedness approaches through the identification of the country's social, political and economic structure and the challenges arising from the current approaches in order to better prepare for future disasters.

CHARACTERISTICS OF A DIGITAL PLATFORM FOR SUPPORTING AN EARLY WARNING SYSTEM FOR DAM BREAKS IN SRI LANKA

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Dams are engineering structures that have a long history of application in general watershed restoration, erosion reduction, and soil conservation. They can be found in a wide range of locations around Sri Lanka. Dams serve a variety of purposes regardless of their size. They primarily provide energy production, and are also used for flow control, navigation, agricultural supplies (mostly for small properties), and water accumulation. Even though there is improved engineering knowledge on dam construction, there may be unanticipated risks due to natural hazards, human actions, and reduction of strength with the aging of the dam. Therefore, the security of populations and the other structures near the valleys should be assured by conducting risk assessments on dams. Hence, it is timely to have in place an early warning system to minimize the impact of dam breaks on the population and other structures while acting as a modification to reduce the risks associated with dam breaks. There are different paradigms such as social, economic, and political structures that have to be considered in early warning systems as they are non-structural systems. Therefore, a digital platform will be an ideal solution to interconnect different paradigms of early warning systems. However, the adoption of digital technology for early warning systems of dam breaks in Sri Lanka is still in its infancy. Thus, this study intends to identify the characteristics of a digital platform to support early warning systems of dam breaks in Sri Lanka.

A FRAMEWORK TO EVALUATE DISASTER RISK ASSESSMENT TYPES DURING URBAN DEVELOPMENT PROJECTS IN SRI LANKA

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Urbanization with unplanned urban growth has led to an increase in disaster risk due to inadequate capacity, unstable governance structures, substandard infrastructure, built environment, and urban services. These have resulted in a very strong need to increase the resilience of urban cities against natural disasters. In order to mitigate the risk of disasters, public policies and disaster response measures are increasingly being tested beyond their capacities and it is very useful to determine the types of pre-disaster initiatives capable of mitigating disaster risk, especially in urban, low-income, and informal settlements. Disaster risk management (DRM) is a part of disaster management, which focuses on the before of the extreme natural event, and relates to during and after of the disaster only through risk assessment. Disaster risk assessment is the first step towards designing and implementing prevention and mitigation of disaster risk. Risk assessment is very important since it produces technical information for the identification of hazardous areas, serves in formulating zoning regulations, establishes population density levels, and designs necessary mitigation actions to reduce hazard risk. There are two broad approaches to risk assessment, namely, qualitative risk assessment and quantitative risk assessment. Lack of technical skills, lack of financial resources, insufficient political support and lack of data discourages urban developers from conducting disaster risk assessments. Moreover, despite professionals having carried out several risk assessments, Sri Lankan people, especially those who live in urbanized areas, continue to face disasters in terms of damage to them and their property. In order to address the current loopholes in disaster risk assessment, this study intends to evaluate the disaster risk assessment types that can be used in urban development projects in Sri Lanka.

FOSTERING LEAN CONSTRUCTION THROUGH HUMAN CAPACITY BUILDING: AN EMPIRICAL STUDY OF THE CONSTRUCTION INDUSTRY

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Due to the lesser responsiveness of conventional approaches to issues such as delays, budgetary constraints and poor-quality of successful project delivery, significant numbers of construction organizations are tending to emerge lean-based approaches. Considering the challenges of lean implementation in the construction industry, most researchers stress that human-related aspects such as lack of training, commitment, lean awareness, lean culture, and required capacities in human resources serve as barriers for lean implementation. Accordingly, lean thinking is fundamentally built not solely upon tools and techniques but also on the knowledge, intelligence and desires of the human resources. Moreover, the fact that building individual capacities to accelerate the sustainable implementation of Lean Construction (LC) has been highlighted by several researchers.

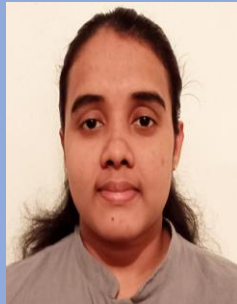
In the Sri Lankan context, several researchers highlighted that human capacity building has the key potential towards successful lean implementation in construction within Small and Medium Enterprises (SME's). the lack of focus on human capacities, which is required to implement LC has further slowed down its implementation. Thus, an investigation on human capacity building for successful lean implementation is a paramount research focus in the construction industry. However, the difficulties and capabilities within large construction organizations engaged in lean implementation may be different from those in construction SMEs. Moreover, there is a lack of evidence from empirical investigations on lean enabling human capacities and strategies in the construction industry for different levels of human resources of large contractors. Therefore this study investigates fostering lean construction through human capacity building in Sri Lankan construction industry

REVIEWING THE APPLICABILITY OF TECHNIQUES IN ARTIFICIAL INTELLIGENCE FOR EFFECTIVE COMMUNICATION IN GREEN CONSTRUCTION

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The persistent high rate of resource consumption in forms such as energy, water, forest use and raw materials has given rise to the concept of green construction in the construction industry. Green building emphasizes the physical development that employs sustainable construction, whereby built or constructed products are created using best-practices and clean and resource-efficient means from the exploitation of raw materials to the demolition and disposal of their residues. Poor communication has negative effects on green practices in each stage of a green project. While the prevailing environmental destruction compels the drive towards green concepts, there is also a remarkable awareness of Artificial Intelligence (AI) applications in the construction industry. Accordingly, this study investigates whether and to what extent AI can be incorporated to have greater communication within a green project. With the growth in the construction industry, there is a great need to encourage the adoption of green concepts for the construction of buildings in Sri Lanka. This study is narrowed down to review the applicability of AI techniques for effective communication in green construction in Sri Lanka. This study will be a significant milestone as there is a dearth of literature focusing on AI applications in the Sri Lankan construction industry. Through semi-structured interviews, this study has identified that there is a positive impact from different AI techniques for effective communication within green construction projects in Sri Lanka.

INVESTIGATION OF BARRIERS TO POLICY IMPLEMENTATION TOWARDS CLIMATE CHANGE ADAPTATION AND MITIGATION IN SRI LANKA

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In recent decades, climate change has arisen as a growing issue all over the world resulting in a number of economic, social and environmental challenges. When it comes to the Sri Lankan context, the situation is almost the same, where the country has been drastically affected by many climate change challenges. Therefore, climate change adaptation and mitigation has been acknowledged as the most appropriate way to counteract these challenges. To date, many institutional actions have been taken in Sri Lanka to formulate and implement different types of policies and plans as adaptation and mitigation responses to climate change. Although such a number of policies and plans have been implemented in Sri Lanka, many barriers can be identified, impeding their formulation and implementation. Basically, these barriers can be identified under different categories such as economic, institutional, informational, technological, social etc. In this context, overcoming such barriers has become a crucial necessity today in Sri Lanka in order to improve climate change policy formulation and implementation activities. However, empirical studies on this perspective are significantly lacking, although the necessity for strengthening policy implementation towards climate change adaptation and mitigation has repeatedly been emphasized. Thus, this study intends to provide a significant contribution on how to improve policy implementation towards climate change adaptation and mitigation in Sri Lanka by identifying the existing barriers in this regard and proposing appropriate strategies to overcome them. After conducting a comprehensive literature review, a document review was conducted to identify the available policies and plans in this regard in Sri Lanka. Thereafter, in-depth interviews were conducted to identify climate change challenges and barriers to climate change policy implementation.

UNRAVELING CONTRACTUAL CHALLENGES AND CONSTRAINTS FACED BY THE CONSTRUCTION INDUSTRY IN A PANDEMIC SITUATION: THE CASE OF COVID 19

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Since the construction sector is one of the main sources of strength in the economy of any country, there should be measures to counter the challenges and constraints due to any pandemic situation.. The pandemic situation due to COVID 19 emphasises the necessity for pre preparation to overcome unforeseen risks as well as for having contingency plans while managing projects in the construction sector. Moreover, it is prudent to address the pandemic's impact at the beginning and end of the crisis in order to prepare for similar events and learn lessons for the future. Construction stakeholders faced many contractual challenges and constraints from delayed projects due to the Corona virus outbreak. Many contractors experienced payment delays from government-funded projects and some clients were reluctant to fund projects due to the prevailing unstable situation. Therefore, stakeholders are seeking time extensions and additional costs to survive within the industry while overcoming delays and disruptions. It is a currently required to pay attention to general and contractual challenges, impacts on stakeholders and minimising adverse impacts from pandemics to the construction industry.



DEVELOPMENT OF A BIOGAS COMBUSTION CFD MODEL FOR THE ANALYSIS OF TRACE EMISSIONS

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Biogas is emitted from landfills, anaerobic digesters and many other biomass sources. Biogas mainly contains methane (CH_4) and carbon dioxide (CO_2). CH_4 and CO_2 have a greenhouse effect of 21 and 1. Emitted biogas is usually burnt in order to reduce the greenhouse effect and obtain energy. The burning of biogas emits several pollutants, mainly CO_2 , NO_x and SO_2 . Reducing emissions is very important in combustion. Emissions of combustion can be analyzed experimentally or by computer simulations. Such experiments are very accurate and expensive. Computer simulations are an economical way of analyzing combustion systems.

There are several methods of reducing emissions in combustion, such as excess air control, air staging, fuel staging, flue gas recirculation and so on. In this study, the effect of excess air in a small-scale biogas combustion chamber is analyzed. Simulation results show that the equivalent ratio from 0.5-1.1 has the highest temperature and the equivalent ratio 0.85-1.4 releases the least NO_x . The range of optimum equivalent ratio for the considered system which gives high temperature with the least NO_x was found to be 0.85-1.1.

Emitted gasses are dissipated in the atmosphere with the wind. The environmental effect from emissions from a 20kW industrial biogas burner in Colombo area was analyzed using CFD simulations. Results show that the ground level is below environmental standard limits.

STRUCTURAL BEHAVIOUR OF THE DOUBLY CURVED SHELL STRUCTURE USING MUD-CONCRETE (MC)

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Mr. K.I.U.Nanayakkara

Dr. F.R.Arooz



Many new construction technologies and materials were introduced and developed throughout the history of the construction industry. However, affordability and implementation of these materials and technologies in developing countries is a challenge. Thus, as a sustainable solution, utilization of earthen materials, and allied construction practices, are ideal for developing countries due to its affordability and low embodied energy. In modern constructions, conventional materials such as concrete and steel are more popular than the earth-based materials. Although there are several earth based modern construction techniques for walling, such as rammed earth, mud-concrete is present in Sri Lanka, no reliable technique is developed or adopted as a slab system. Most of the recent earthen constructions are either single storied or use concrete as their slab system. Thus, the earthen slab system would be a huge step towards a structure fully made of earthen materials. Researchers have developed thin tile vault slab systems using barrel vault shell structures. However, there are several challenges that arise when thin tiles are used for the construction such as difficulties during manufacturing and handling process of thin tiles, requirement of binding agents, time consumption, etc. Thus, the attempt here is to identify the structural behaviour of the doubly curved shell structure using Mud-Concrete and go for fully earthen multi-storey constructions while fulfilling the sustainable demands in the construction industry.

INVENTORY ALLOCATION BEHAVIOR OF THE DISTRIBUTOR DURING A DEMAND SHOCK - PROMOTIONS

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Manufacturers often pool inventory to serve downstream requirements at their fulfillment or retail locations due to many benefits including lower inventory investment through reduced safety stock levels, lower product acquisition cost and lower distribution cost. The main problem of such integrated distribution system arises when allocating pooled inventory across downstream partners. In practice, when the retailers experience a local market demand, they place orders to their distributor who attempts to allocate inventory accordingly.

However, when retailers face with an uncertainty of demand shock, they tend to make biased decisions. Moreover, uncertainty regarding the magnitude and timing of a demand shock induces retailer to overstock where they order too much inventory too early. This ordering behavior of the retailer (who places orders to the distributor) is more likely to affect the behavior of the distributor who tries to allocate the inventory based on inventory availability. Thus, the distributor struggles to identify what allocation mechanism is best under such a demand shock. For example; the distributor has to decide whether he is going to allocate proportionally to each retailer's order, equally split any shortages or excess inventory or match order quantities for some retailers but not others. Our research study investigates the inventory allocation behavior of the distributor under a positive demand shock.

COMPENSATION OF MUSCLE FATIGUE EFFECT ON ACTIVE COMPLIANCE CONTROL OF A HIP EXOSKELETON ROBOT IN STOOP LIFTING

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Among different types of exoskeletons used by humans, a strength enhancement exoskeleton utilizes actuators to provide extra forces on joints directly, thus enhancing the musculoskeletal strength of the user. The Human-Robot Interaction (HRI) of these robotic exoskeletons must be characterized by high compliance or low impedance properties, which is achieved using active compliance controllers. User intention estimation, which is the highest level of active compliance control, has been achieved using EMG-based muscle torque estimation in literature. This torque estimation method maps the acquired EMG signals to muscle torques using an EMG-to-torque model. However, the neural-to-muscle activation relationship in this method depends on many external factors and muscle fatigue is one of the prominent EMG features utilized in previous work to identify and quantify the muscle fatigue manifested in EMG signals. Spatial information obtained from multiple-channel EMG has shown better reliability in muscle fatigue identification when compared with single-channel information. A compliance-controlled exoskeleton with a muscle torque estimator which accounts for the identified muscle fatigue can be expected to have better performance when compared with existing ones, especially for assisting demanding tasks, like stoop lifting. However, muscle fatigue quantified using multiple-channel EMG has been rarely involved in improving the high-level control of exoskeletons. In this research, a muscle torque estimation-based compliance controller, with a fatigue effect compensator for exoskeletons will be developed. Furthermore, the fatigue effect identification will be based on multiple-channel EMG signals.

EXPERIMENTAL EVALUATION OF DSRC/WIFI HYBRID SYSTEMS IN INTELLIGENT TRANSPORTATION SYSTEMS

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An Intelligent Transportation Systems (ITS) is a collection of applications which improves the safety, efficiency, and the availability of information in transport systems through the usage of advanced technologies from multiple engineering disciplines. Being a development in the telecommunications engineering discipline, Dedicated Short-Range Communication (DSRC) caters to most of the communication requirements of ITS applications in the world. However, DSRC equipment are scarce and hence expensive. This research focuses on designing an alternative communication system to replace non-essential DSRC nodes in ITS applications. Two of the most popular and inexpensive communication technologies are Wi-Fi and Bluetooth. Unlike Bluetooth (IEEE802.15), DSRC (IEEE802.11p) and Wi-Fi (IEEE802.11 b/g/n/ac) share the same IEEE802.11 core protocol. Hence, most of the functionalities of DSRC, can be implemented using Wi-Fi. Therefore, Wi-Fi was chosen for this implementation.

The system was designed such that, it could be deployed in hybrid with DSRC devices which will be equipped in high priority vehicles (trains, ambulances, etc.). The system has a Hybrid Device, an Extender/Road-Side Device, and an In-Car Device. The Hybrid Device converts DSRC messages of priority vehicles into Wi-Fi messages, and repetitively sends out Wi-Fi beacons. Depending on the requirement, Extender Devices can be used for range extensions, or they can also be deployed as standalone roadside traffic/warning signs. Finally, the In-Car Devices translate Wi-Fi beacons into human readable messages/warnings. The system performance was found to be in acceptable range for most of the ITS applications. Also, system components are inexpensive and can be used for retrofitting and thereby overcome the cost constraint of DSRC.

**LOCAL CRAFTS AND DESIGN BUSINESS STRATEGIES:
WITH SPECIAL REFERENCE TO BATIK CRAFT PRACTICE
AT ALUVIHARE HERITAGE CENTER (AHC)**

Jayamanne Mohottige Don Kasun Priyasad Jayamanne

Department of Integrated Design

Supervisor (s)- Ms. Ruwandika Senanayake

Arch. Channa Daswatte



The emerging creative economy is an important aspect of the overall economy of contemporary Sri Lanka. Most of the equipment, tools and products that Sri Lankans made at the cottage level in the past have turned into cultural industries at present. Furthermore, they have developed into a way where a profit can be earned economically. For example, craft practices such as earthenware, rush and reed products and textiles have become industries that could contribute towards the country's economy. Today, in the global context, cultural industries with creative inputs play a major role on the creative economy. The creative economy is about the relationship between creativity and economics. Creativity is not new and neither is economics, but what is new is the nature and extent of the relationship between them and how they can be combined to create value and wealth. As a country with an agriculture based economic background, Sri Lanka can be considered to be still novel to the concept of "Creative Economy".

Sri Lanka has also started focusing on earning an economic profit through creative practices. As identified in the creative industries mapping report Creative and Cultural Industries in Sri Lanka, industries such as Arts and Crafts, Music, Architecture, Design, Performing Arts, Film industry, Advertising, Video games and Photography can be considered to be examples for this. Local crafts have received a prominent place here.

Local craft communities and groups with both traditional and cultural values embedded within them have been continuing their industries even at present. It can be observed that these artisans strive to maintain the persistence of their industries despite any social, economic or political impacts. Both the government and non-government organizations conduct projects to uplift the local based industries as well as the livelihood of these artisans. A major factor that should be taken into consideration at this point is that it is important to support these communities while preserving their unique characteristics and their knowledge.

However, Sri Lanka has also taken a position to make many of these emerging aspects of its economy to be sustainable and ethical. Therefore, understanding the ethical and sustainable business systems that were indigenous to more traditional and cultural craft communities is very important. The 'Aluvihare Heritage Center' (AHC) in Matale which is also known as "Aluvihare Workshop" established in 1982 by Ms. Ena de Silva Aluvihare is such an ongoing art, craft and design based business practice in Sri Lanka. At the time the AHC was established, Ms. Aluvihare was living in Colombo with her family. AHC is one of the best resources to study the local craft based business models. Meanwhile it is also a good example to elaborate the manner in which the business potentials of arts, crafts and designs can be identified and used for the development of the economy of a country. In order to maintain a sustainable design business while managing the traditional and cultural values, as well as the human resources, one must definitely possess a strategic and a proper management skill. Such strategic approaches can be identified when the system of the AHC is examined. Several strategies that should be taken into consideration while carrying an art, craft and design related business in the local context, was studied through this research.



EFFECTS OF MULTIPLE ADJUSTMENTS IN SUPPLY CHAIN FORECASTING ON FORECAST ACCURACY

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Multiple adjustments in forecasting are considered to be a common occurrence and self-evidently refers to adjusting a forecast multiple times by multiple stakeholders. Previous survey-based global research has indicated that this is a common practice in the industry. However, only a few researchers have researched adjustments of previously adjusted forecasts leaving a knowledge gap.

This study aims to answer the following research questions.

1. Would forecast accuracy due to multiple adjustments by the forecaster be different than unadjusted forecasts?
2. What is the effect of the forecasters' experience on forecast accuracy regarding multiple adjustments?
3. Would sharing information of previously adjusted forecasts impact multiple adjustments?

A laboratory experiment was deployed to test the effects of multiple adjustments in supply chain forecasting on forecast accuracy. The laboratory experiment was developed through R Language and the R Shiny web development tool as an online web application. This experimental study includes one control group and three other treatments (Treatment 1, Treatment 2, and Treatment 3). 40 compulsory rounds were employed (10 test rounds and 30 core rounds) under each treatment. Participants were given 60 seconds to determine and put their final sales forecast in each run.

AN OPTIMIZATION MODEL FOR THE MULTI-OBJECTIVE VEHICLE ROUTING PROBLEM FOR PERISHABLE GOODS DISTRIBUTION

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The Vehicle Routing Problem (VRP) is a widely researched area in Operations Research. The problem is introduced as the "truck dispatching problem". Extant literature highlights a research gap in the richer problems which use real-life complexities simultaneously. The Vehicle Routing Problem for Perishable Goods (VRPFPG) distribution is a unique application area. Since perishable goods lose their quality rapidly, planning an effective distribution process is critical to minimize wastage. Inefficient transport systems result in a loss of approximately Rs 20 billion loss annually for the Sri Lankan agricultural economy. This study focuses on to developing a multi-objective VRPFPG incorporating real-world complexities.

As the VRP is an NP-hard (non-deterministic polynomial-time hardness) problem, exact algorithms are only efficient for small problem instances. Thereby this study intends to test several meta-heuristic methods to solve the proposed problem. Solution methods will be developed using OR Tools which is an open-source software used to solve optimization problems. Further, computational experiments and data from a real-world case study of a Sri Lankan retail chain will be used to analyze the feasibility of the model and real-life applicability.

ASSESSING SOCIAL SUSTAINABLE PRACTICES OF THE APPAREL AND TEXTILE SUPPLY CHAIN USING ADVANCED ANALYTICS

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At present, expectations of global apparel consumers are changing drastically with the frequently changing fashion trends. Due to this, apparel retailers are searching for ways to reduce the cost and lead time of their products (Masson et al., 2007). Therefore, western apparel retailers began to source their products from developing countries to obtain a competitive advantage from low labour cost (Ashby et al., 2013). With this, employment opportunities were provided to a large number of employees in these countries. However, this situation was associated with poor working conditions that led to labour issues in the apparel industry (Chen et al., 2017). To find solutions, practitioners integrated sustainability concepts into the apparel supply chain. Sustainability consists of three pillars: economic, environment and society. Moreover, the social pillar has been recognized as an underreported area within sustainability (Bendul et al., 2017). Therefore, previous literature highlights that there is a gap in assessing the impact of social sustainable practices on the economic performance of the supply chain.

Research Objectives

Identify factors that should concern when implementing social sustainable practices



INTEGRATING INTRALOGISTICS TO OPTIMIZE STOCKFLOW AND GOODS REPLENISHMENT AT WAREHOUSES

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Converting warehouses within the supply chain into smart environments is becoming a trend with the revolution of Industry 4.0. Controlling and managing procedures through a centralized system can be identified as a main feature within the mentioned trend. Intralogistics has been proven as a concept emerging in research and development domains. Optimization, automation, integration, and management of logistics flow within a distribution center or fulfillment center constitutes intralogistics. The interaction between industry 4.0 technologies such as the IoT (Internet of Things) has largely enabled robust connectivity between physical processes and systems. These integrated technologies contribute to automating warehouse processes and improving efficiency while cutting costs. Various automation solutions and systems can execute logistics activities, minimizing human intervention. These smart solutions can plan and control workflow in the dynamic environment at the warehouse. Presently, a key challenge in warehouses is to capture the movement of physical goods in real-time and control stock fluctuations in a manner that manages replenishment. Warehouse management systems focus on controlling the material flow of the warehouse considering inventory conditions and assignment of locations. Integrating warehouse systems with intralogistics solutions which are developed in the form of optimization and automation will enhance the functionality of handling advanced processes. Even though, previous literature has discussed intralogistics solutions for handling warehouse operations broadly, knowledge related to stock-flow management and goods replenishment is scarce. This study identifies the impact of intralogistics solutions to improve the stock-flow and goods replenishment.

RETAIL SALES FORECASTING IN THE PRESENCE OF PROMOTIONAL PERIODS: A COMPARISON BETWEEN STATISTICAL AND MACHINE LEARNING METHODS

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Sales promotions are a common phenomenon in the retail industry. Sales promotions often make demand shocks before, during and after promotional periods. However, past literature mostly focused on modelling the promotional effect and often ignored the post-promotional period. This study focuses on all promotional periods; normal, promotional, and post-promotional to generate forecasts at stock keeping unit level using well established univariate models and machine learning models. The performance of machine learning methods is compared with an established model, base-lift model in the retail industry. The findings show that machine learning models can effectively utilize available information to generate improved forecasts compared to univariate models. However, the base-lift model performed similar to the machine learning methods with a requirement of extra effort to cleanse the sales data. This study shows the manner in which retailers can effectively implement machine learning based models to perform sales forecasting.



APPLYING OPTIMIZATION TECHNIQUES IN SEAPORT CONTAINER TERMINAL OPERATIONS

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The annual average growth of containerized trade between 2019 and 2024 has been predicted as 4.5%. Container terminal operations planning is extremely complex since global shipping lines demand their requirements at a competitive price in a dynamic environment. Optimization is needed for container terminals to provide better productivity at low cost. Therefore, understanding the paths to optimize the container terminal operations is critical for the growth of the industry. Systematic reviews can provide an overarching image on a specific area of research. It is identified that there are only a limited number of systematic reviews available in the field of maritime logistics, not only in container terminal operations. Therefore, available systematic reviews that cover maritime logistics are identified. Accordingly, there are 7 clusters. 1) Truck appointment systems, 2) Container terminal automation, 3) Integrated planning 4) Handling equipment, 5) Modeling and simulation, 6) Yard optimization and 7) Computational modeling. It is apparent that there are no systematic reviews published after 2008 within the narrowed scope of container terminal optimization. Operations research techniques have been discussed in recent literature heavily. Therefore, it is intended to develop a systematic review covering operations research techniques in container terminal optimization as the first phase of the project. The limited understanding on 1) ITT (Inter-terminal Transportation) operations, and 2) Integrated operations and dynamic approaches in container terminals is noted. Therefore, it is intended to work on developing an integrated model to optimize the integrated operations within ITT operations function. Currently AI techniques to use to develop the model are being tested. The overall objective is to optimize the ITT operations in container terminals to create a space to optimize the overall supply chain through container ports.

MODELLING THE VEHICLE ROUTING PROBLEM TO OPTIMIZE FREIGHT LOGISTICS MULTIPLE ECHELON NETWORKS

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Freight transportation is one of the main activities that impact the global or national level economy, trade, and markets while ensuring a pivotal role in connecting suppliers and customers. Two main distribution strategies in current freight transportation can be identified as direct distribution and multi-echelon distribution. In direct distribution, the transport network starts from a source and freight is transported directly to the delivery point, while in multi-echelon distribution systems, intermediate points (warehouses, satellites, etc.) are involved between the source and delivery point. The Vehicle Routing Problem (VRP) is one of the widely studied topics in the field of transport and logistics related to operational research. This study attempts to model the vehicle routing problem to optimize multiple echelon networks. A research gap was identified in air cargo distribution in city logistics. Further there is a scarcity in studies focusing on three echelon networks and the vehicle routing problem.

Research objectives: Identify the process of optimizing each echelon separately through the vehicle routing problem in the air cargo distribution network. Then, formulate a model for the vehicle routing problem in the multi-echelons network. Finally, evaluate the effectiveness of the proposed method and its applicability for a practical scenario in air cargo distribution.

With regard to methodology, the multi-echelon freight logistics network routing optimization will be considered and firstly, the problem will be considered in multiple echelons separately for optimization. Then algorithms and models will be formulated using suitable techniques following laboratory experiments.

AN ADAPTIVE SOFTWARE ARCHITECTURAL FRAMEWORK FOR AN INTERACTIVE LEARNING TOOLKIT

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Department of Computer Science and Engineering

Supervisor (s)- Dr. Dulani Meedeniya



In this era of technology, anything and everything is possible. However, there is a visible lack of a suitable system to provide intelligently customizable education, specifically to deliver the primary education syllabus in a well-designed and an interactive manner. This has prevented the Sri-Lankan education sector from adopting to these rapidly evolving times and from gaining the optimum use of this remarkable infrastructure. Furthermore, there is a lack of an application which provides learning content in the Sinhala language, which is the medium in which the majority of the students in Sri-Lanka study. Therefore, there is a growing need for an interactive learning toolkit with self-paced learning supported in the Sinhala language, that can enhance student engagement in the learning activities, in and outside the classroom.

Therefore, this research is intending to develop an architectural framework for a mobile learning toolkit that can be used as a platform for teachers to create interactive video lessons. This will help to keep students actively engaged in the learning process, as well as to provide a mode to evaluate the progress of the students in real-time. Furthermore, this framework is expected to enable knowledge-based adaptivity for students in this highly customizable platform. Moreover, the mobile application will be equipped with important non-functional requirements such as usability and performance to ensure that the majority in the education sector will be able benefit from it. To implement this architectural framework, the primary education sector of Sri-Lanka was chosen as the case study domain

DEVICE-FREE DETECTION OF HUMAN MOVEMENT IN OUTDOOR ENVIRONMENTS USING WI-FI CHANNEL STATE INFORMATION

Nayan Gokul Dharmanraj

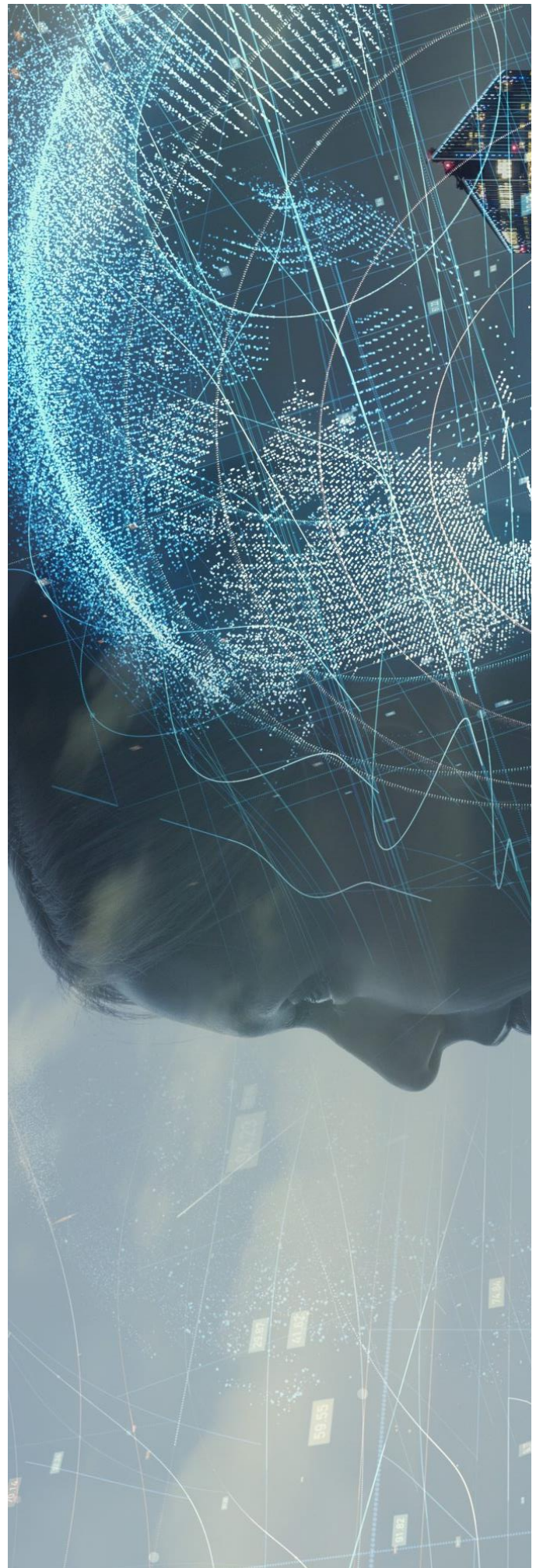
Department of Electronic and Telecommunication

Supervisor (s)- Prof. (Mrs.) Dileeka Dias

Dr. Kasun T. Hemachandra



Device-free, non-vision-based human activity recognition is gaining importance due to privacy, environmental and cost concerns related to vision-based systems. Some popular approaches involve using received signal strengths (RSSI) and/or Channel state information (CSI) of wireless signals. As Wi-Fi is ubiquitous and of low cost, it is a promising technology for this purpose. This motivates to investigate the ability of Wi-Fi CSI to sense the presence and movement of humans in a truly outdoor environment. The estimated CSI of an orthogonal frequency division multiplexing (OFDM) system provides information on the propagation channel experienced by its subcarriers. In OFDM based Wi-Fi standards such as the IEEE802.11a/g/n/ac/ax, the CSI is estimated using pilot subcarriers as the channel's amplitude and phase response at each subcarrier, is representative of the multipath propagation and Doppler effects experienced by the signal. Hence, CSI provides rich, fine-grained information on the channel dynamics in the physical layer (PHY) compared to a single RSSI value measured at the receiver. Refining the frequency domain estimations to extract salient characteristics in CSI due to the movement of people across the link can be achieved with a deep learning and statistical analysis. Popular approaches of analysis of wireless signal features include clustering algorithms such as K-means, multi-class image classifiers or a threshold-like detection scheme such as Support Vector Machine (SVM) and Random Forest model classifications helps perceive changes in CSI over time for movements across the wireless link. A typical application of the proposed research is to investigate the detection of people moving across a pedestrian crossing. As part of an intelligent transport system, this type of information would help in alerting oncoming traffic to enhance the safety of pedestrians especially in low visibility conditions.



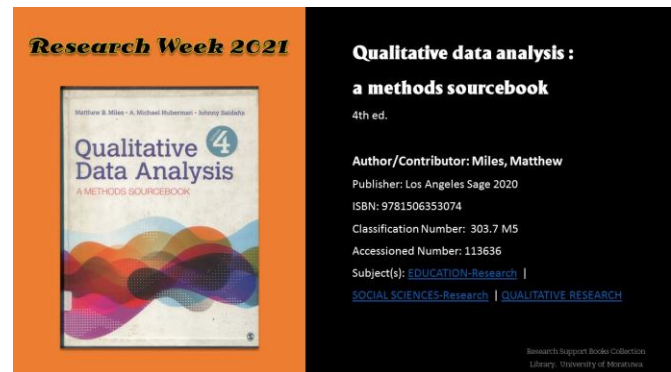
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