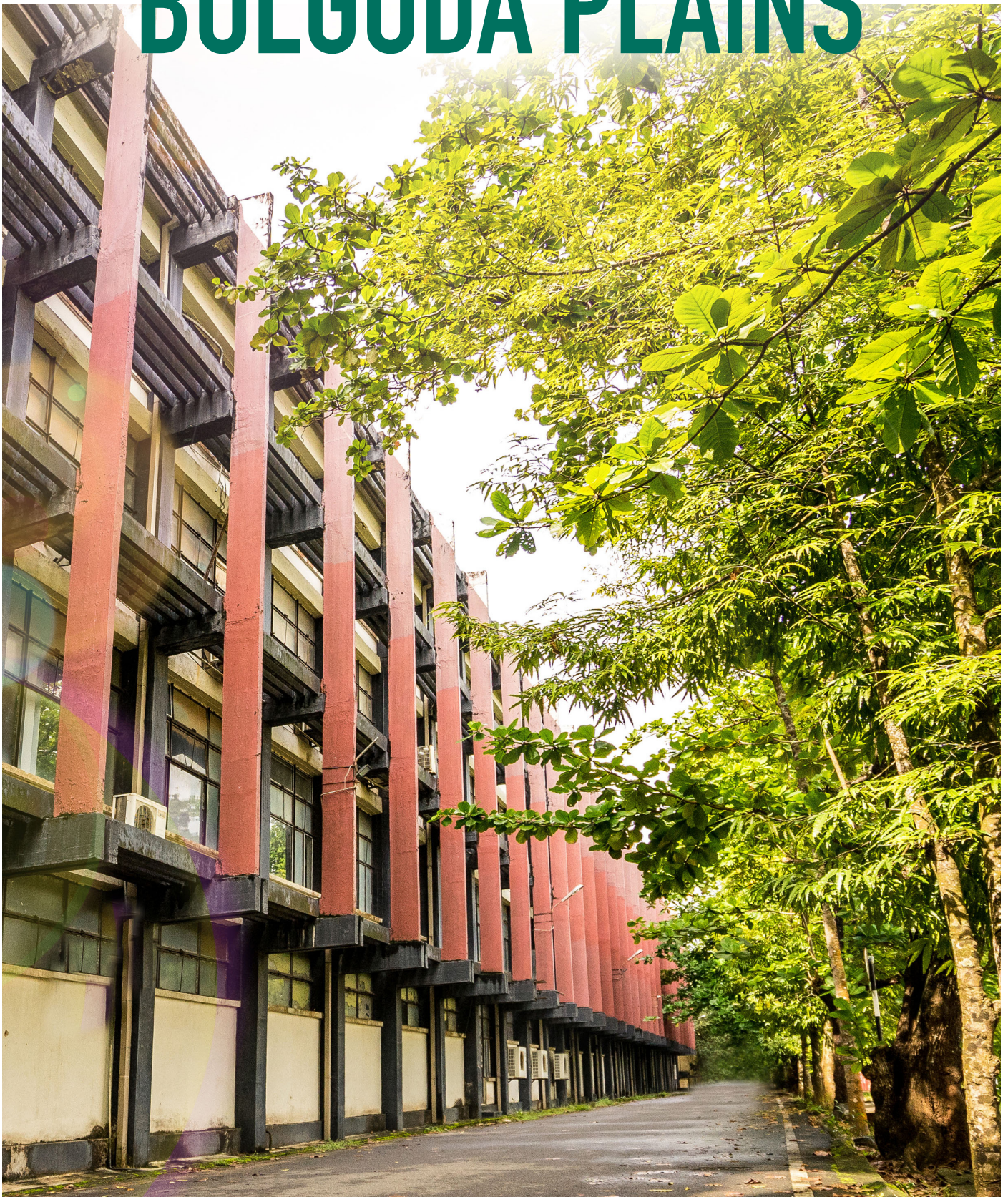


Research Magazine of the University of Moratuwa

BOLGODA PLAINS



University of Moratuwa, Sri Lanka

December 2021

Faculty of Graduate Studies






The Faculty of Graduate Studies was established in January 2015, with the goal of enhancing the University's research degree programmes. High quality research has become as important as teaching to gain better international recognition and competitiveness. Research, being the cornerstone of an academic career, is a key factor in retaining the high-calibre academics that the University is home to.

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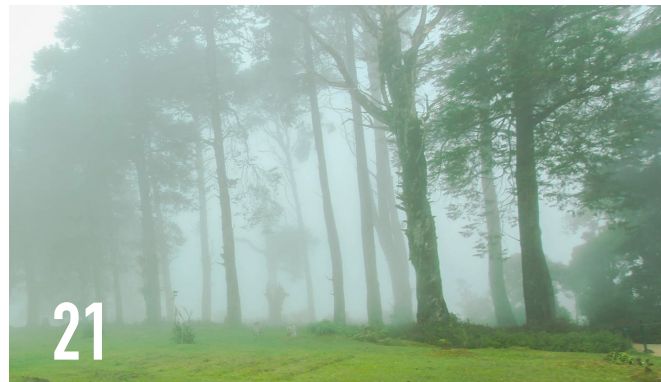
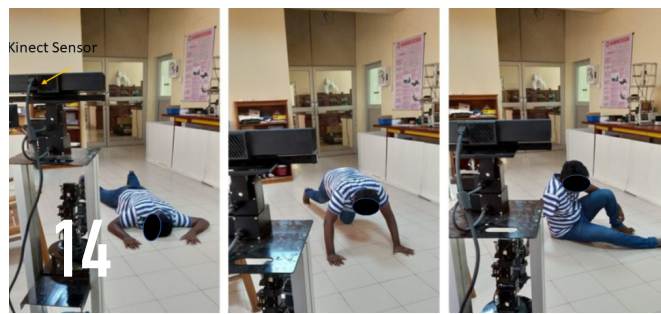
Volume 1, Issue 2



University of Moratuwa, Sri Lanka
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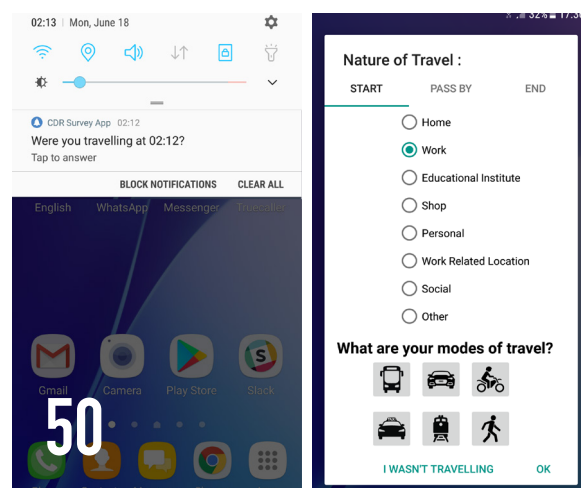
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Editor's Note

A walk in the plains of Bolgoda

Springing from the headwaters, a river finds its way to its destination, embracing a multitude of brooks, creeks, and tributaries facing many riffles, rapids, and eddies along the way. However, the water flow never gets halted, and dearly confluences, carrying many hopes for a brighter future.

As a seed of hope, we planted "Bolgoda Plains" in the soil of the University of Moratuwa, anticipating many outcomes. Most importantly, we desired to lay the foundation for a thriving research culture within the boundaries of our beloved university. However, like any plant, it needs constant care and manoeuvring to grow in leaps and bounds.

The second issue of "Bolgoda Plains" aspires to strengthen the roots of our research culture. A thriving research culture can only be fostered within a vital ecosystem. In this issue, we communicate the exploits of UoM research endeavours by bringing multiple stories. Empowering multidisciplinary and diversity, we entrust our researchers could voice the real needs of the society through their hard work and commitment.

Walking in the plains of Bolgoda, I reminisce the story thus far with much hope and gratitude. The second issue of "Bolgoda Plains" honours our pledge to sustain the momentum of our fundamental purpose. I offer my sincere appreciation to all UoM researchers for sharing their invaluable contributions with us. Further, I extend my profound thanks to the Board of advisors, Editors-in-chief, members of the editorial, e-Editorial boards and all editorial and technical assistants for their continued support and labour. They are the threads that weave the thoughts of UoM researchers.

As the river Bolgoda flows, I am confident that our "Bolgoda Plains" efforts will bear the fruits in their own pace of time. The journey has just begun, and there will always be more to endure, encounter, and experience. Hence, let us not rest on our laurels and keep our eyes awake for a brighter future.

Prof. Vathsala Wickramasinghe
Editor in Chief



Cover Story: The article: Scholarly Output: 2015 ++ Speaks of how a University that started with a single building with traditional teaching started moving forward to a University that excel in research and innovation.

It elaborates on the establishment of the Faculty of Graduate Studies, its growth and way forward. That being said, we invite all readers to enjoy, explore and reflect on the 'UoM Researcher'!

Path towards a sustainable bioeconomy: Conversion of locally available rice straw to nanocellulose

Extract: The Sri Lankan agriculture sector has the potential to support a national bioeconomy. Rice straw is a key by-product generated from paddy cultivation. While it is traditionally treated as a waste matter, straw can be a valuable resource in producing biomass fibers in the green composite production due to properties such as recyclability, biodegradability, renewability, nontoxicity, and high functionality. Comprehensive investigations have been carried out on the chemical, mechanical, and thermal properties of cellulose fibers extracted from locally available straw. The study outcomes can help in determining how this material can be effectively used in various applications.



Path towards a sustainable bioeconomy: Conversion of locally available rice straw to nanocellulose

Nowadays most of the developing countries are adopting bioeconomy as a path towards achieving their Sustainable Development Goals (SDGs). Contribution of bioeconomy can be measured either in terms of employment opportunities and value addition, or social and environmental aspects. Sustainable use of natural resources and renewable biomass is one of the contributors to a sustainable bioeconomy.

Agriculture sector in Sri Lanka is significant in terms of land resource utilization as well as labor deployment. 21st century is directing economies to go circular as well as embrace a bioeconomic approach. In that context, the paddy production can be viewed in a completely different perspective.

Paddy is cultivated as a wetland crop in almost all parts of the country except at very high altitudes with traditional or technically modified varieties. In addition to health benefits, traditional rice is recommended for those who suffer from non-communicable diseases. Traditional rice varieties also possess robust and unique characteristics which make them resilient to diverse climatic conditions like floods, heavy rains and drought. On the other hand, technically modified rice varieties were developed to get the characteristics lacking in traditional varieties such as high yield, greater resistance to pests and diseases, increased response to fertilizer, and better grain quality etc.

One of the major by-products generated from paddy cultivation and processing is rice straw. It is considered as agricultural waste in the country since it has less commercial value and has not been converted into any valuable by-product. Rice straw is a lignocellulosic biomass composed of both organic and inorganic matter. Cellulose, lignin, hemicellulose, some proteins and vitamins are the organic components while the major inorganic mineral component is silica.

Cellulose is the most abundant natural biopolymer on earth which is gaining the momentum as an ideal replacement for synthetic fibers that are currently in use. It is also a suitable candidate for

“rice straw is considered as agricultural waste in the country since it has less commercial value and has not been converted into any valuable by-product”

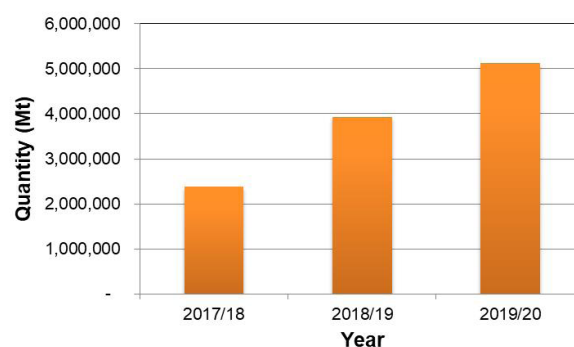


Figure 1: Total paddy production during Yala and Maha seasons in Sri Lanka

(Source: Department of Census and Statistics, Paddy Statistics, 2017/18, 2018/19 and 2019/20)

biomass fibers in the green composite production due to their properties such as recyclability, biodegradability, renewability, nontoxicity, low density, some favorable mechanical properties, and high functionality.

As a path towards value addition of this commercially under-utilized waste, initially cellulose fibers were successfully extracted from locally available straw of traditional and technically modified rice varieties via a series of chemical treatments. These chemically extracted cellulose fibers were then disintegrated into micro and nano-cellulose using chemical and mechanical processes. Also a comprehensive investigation of structural, morphological and thermal properties of these chemo-mechanically extracted cellulose, micro-cellulose and nanocellulose were carried out.

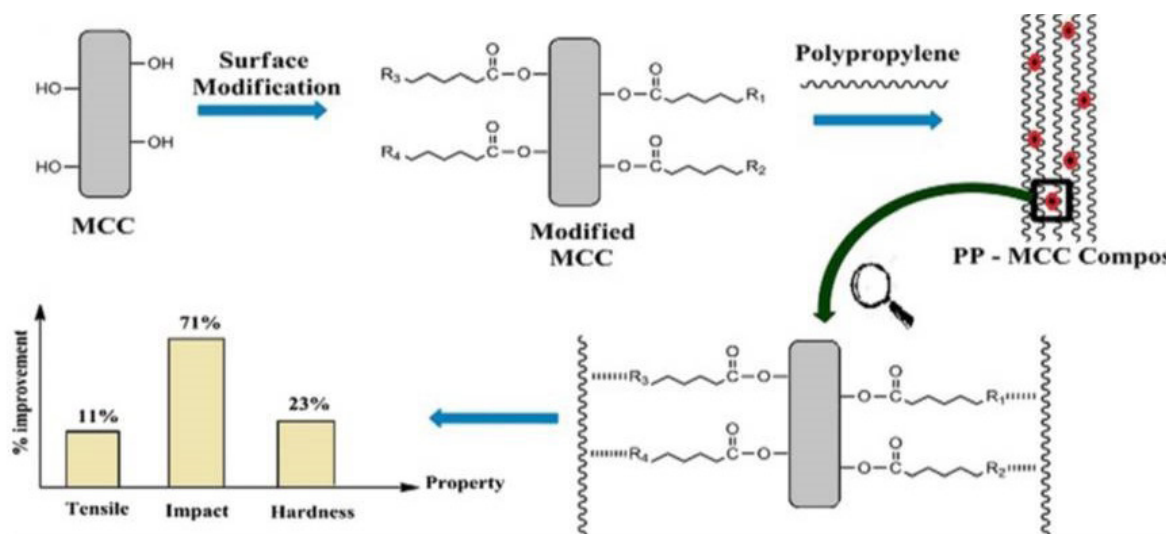


Figure 2: Microcellulose (MCC) surface modification to achieve improved thermo-mechanical properties of a polypropylene composite

Furthermore, a bio-based approach was studied to enhance surface hydrophobicity of microcellulose and thereby improve the compatibility with a hydrophobic polypropylene (PP) matrix. This environmentally friendly green chemistry approach introduces a monomolecular long-chain fatty acid layer on the microcellulose surface, making the surface hydrophobic. The inclusion of surface-modified microcellulose in the PP matrix significantly improved the thermo-mechanical properties and thermal stability of the composite. The improved compatibility between microcellulose and PP also reduces gap and flaw formation at the fiber and matrix interface, lowering the water uptake of the modified microcellulose-PP composites.

Apart from this, these micro and nanocellulose fibers can be utilized as reinforcement for nanocomposites, protective coatings, barrier membranes and filtration systems, scaffolds for tissue engineering, drug delivery systems and antimicrobial films. The findings of these studies will not only add value to the commercially under-utilized waste rice straw and also emphasize sustainable transition to a bioeconomy in the country.

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Article by

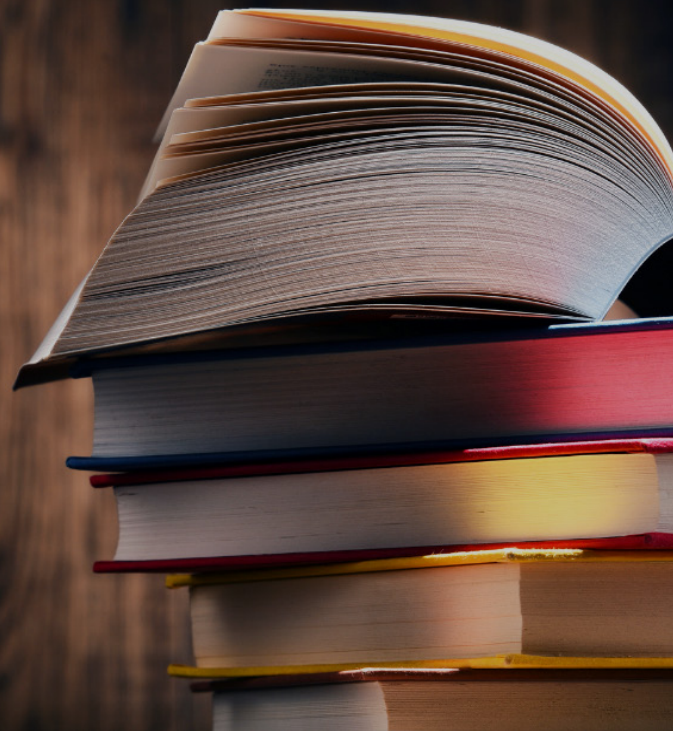
Abirami Ratnakumar¹, Bandu Samarasekara¹, Shantha Amarasinghe¹, Shanari Rathnayake², Lalin Karunanayake³

¹Department of Materials Science and Engineering, Faculty of Engineering, University of Moratuwa, Sri Lanka

²Department of Chemistry, Faculty of Applied Science, University of Sri Jayewardenepura, Sri Lanka

³Department of Polymer Science, Faculty of Applied Science, University of Sri Jayewardenepura, Sri Lanka

SEEKING NEW FRONTIERS FROM THE SHOULDERS OF GIANTS – THE POWER OF SYSTEMATIC REVIEWS



A literature review is where a solid research begins. However, it is likely that two researchers conducting a literature review independently on the same domain may conduct the review differently with varying results. Thus, systematic literature reviews have emerged as a solution to provide a scientifically derived and replicable solution. Initially emerging from the field of medicine, systematic reviews have often been misunderstood [1], [2]. Systematic reviews are ideal in understanding the state-of-the-art while giving insights on how research on the domain should evolve. They are an ideal source for any researcher to venture out on their research journeys [2]. Hence, it is no surprise that good systematic reviews generally end up generating a lot of citations.

The starting point of a systematic review is precisely defining the scope of the study. A good systematic review should have access to one or more research databases (i.e., Scopus, Web of Science, ProQuest, or IEEE Xplore) that are rich in literature on the domain you wish to conduct a systematic review. Then begins the process of developing a keyword structure that is aimed at capturing all relevant works in the defined scope. Developing a successful keyword structure takes time as it requires patience and diligence to define the levels according to the scope as well as populating them with the right keywords and Boolean operators. Moreover, refining the search results to remove irrelevant papers cannot be done arbitrarily. Therefore, a replicable method is paramount in that process [3]. Oftentimes, systematic reviews focus purely on journal articles published in English [2]. Defining exclusion keywords or removing subject areas after careful inspection are examples on how to refine the search results while manually inserting relevant papers is also facilitated to some degree.

Things get complicated when you have no option but to work with open ended keywords.

<i>Steps</i>	<i>Process</i>
1) Initial search	Searching literature on Scopus using primary keywords
	Narrowing the literature pool based on subject areas
	Filtering only peer-reviewed journal articles on Scopus published in English
2) Systematic exclusion of irrelevant papers	Using exclusion keywords to remove irrelevant publications
3) Manual pruning of search results	Assessing individual papers independently and reaching consensus on the final pool of papers
4) Verification with reference lists	Perusing reference lists of relevant literature reviews and prominent papers to find missing papers

Figure 1: Example of the steps/processes associated with a systematic review [1]

For instance, "port" may refer to a seaport or a telecommunications port while "operations" may refer to a surgery or to operations within a factory. Once the authors are satisfied with the search results, the data must be captured through a data dump. It is generally advised to seek the validation of prolific authors on the finalized paper pool in addition to ensuring that no relevant papers are left out through referring to recent literature reviews within the domain, checking reference lists of papers within the pool as well as through other databases [2]. An example of the step by step process followed in a systematic review is presented in Figure 1 to illustrate this point.

Then the magic starts to unravel through meticulous work. Using numerous publicly available software as well as programming, the downloaded data can be subjected to a bibliometric analysis to discern salient features within the research scope. These include but are not limited to, major research clusters within the scope and their evolution, top authors and institutions within the scope, top journals contributing to the field, salient

“ Using numerous publicly available software as well as programming, the downloaded data can be subjected to a bibliometric analysis to discern salient features within the research scope ”

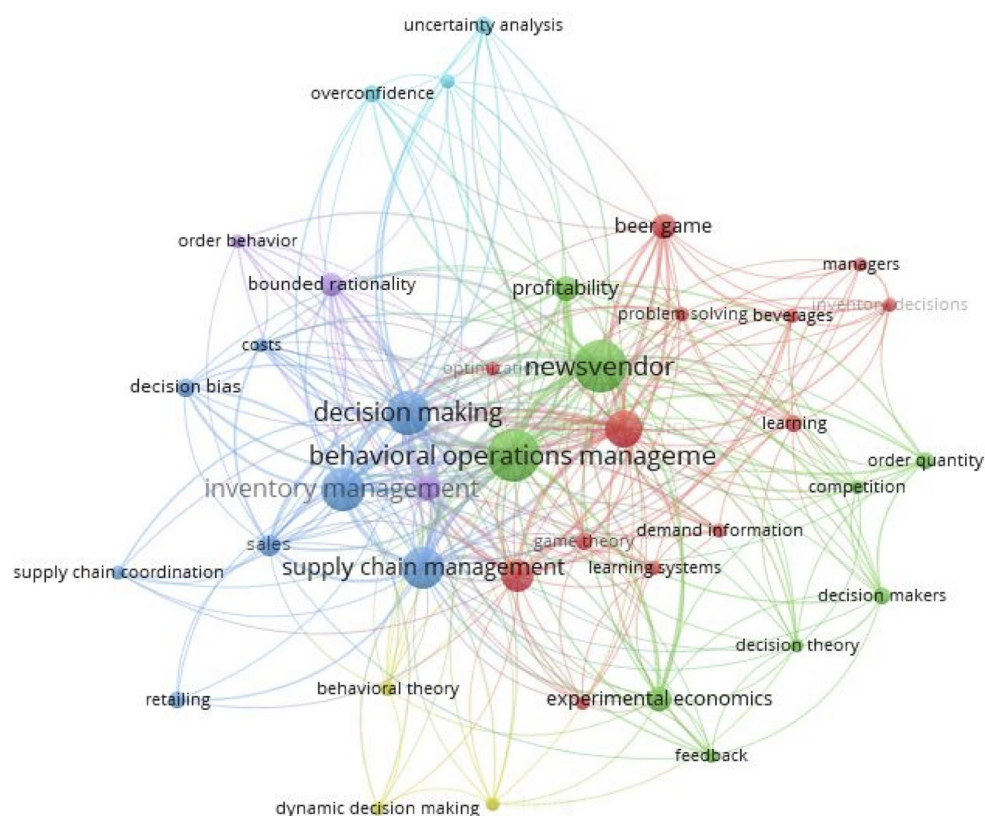


Figure 2: An example keyword cluster that elicits the interrelations of keywords within the focal domain [2]

collaborations, popular methodologies [1], [3]. This allows the authors and readers to clearly understand the exact state of knowledge within the scoped domain and to foresee what are the research gaps while arguing on the shape and direction of the new frontier [3]. For instance, Figure 2 provides an example of a keyword network in the domain of inventory decision research using behavioral experiments. Many fields lack comprehensive systematic reviews synthesizing the extant knowledge and pointing towards the future. Thus, Q1 journals are eager to publish meticulous systematic reviews that leave no stone unturned. While getting there is not easy, it is an enriching journey where one can make a significant contribution to literature while thoroughly comprehending a field.

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Article by

Niles Perera

Department of Transport & Logistics Management, Faculty of Engineering, University of Moratuwa, Sri Lanka

Intelligent Fall Detection and Notification System

for IoT based Smart Home Environments

Throughout the history of technology, various mechanisms to support the elderly and the disabled have been introduced as a remedy for the inadequacy of caregivers to provide them with the required assistance in leading an independent and secure living. Among all those mechanisms, smart homes and social robotics appear to play a significant and effective role in assuring a comfortable and safe environment for the elderly and the disabled who prefer to live independently without causing an extra burden on their families.

However, most of the existing assistive systems lack the required levels of accuracy and timeliness which causes increased probability of resulting them in higher risk of damage after encountering an emergency while staying alone at their homes. Therefore, in order to ensure the availability of timely assistance and support, the introduction and development of effective emergency detection and notification systems is an essential necessity in the present world.

With the intention of catering this requirement, Tharushi Kalinga, a member of the Intelligent Service Robotics Group (ISRG) of the Department of Electrical Engineering, University of Moratuwa, recently defended her MSc under the Thesis Title: Intelligent Fall Detection and Notification System for an IoT based Smart Home Environment, with the supervision of Prof. Buddhika Jayasekara and Prof. Indika Perera.

This research introduces a Smart Home System consisting of three subsystems integrated together over an IoT (Internet of Things) Cloud with the main objective of improving the quality of life of the elderly and the disabled by providing them with ample support in performing their activities of daily living without compromising their safety and independence.

The proposed system presents a novel vision-based method of detecting falls from standing or walking positions that is also capable of distinguishing the identified falls among three types so that the medical attention could be easily focused. A special subsystem is also introduced for the identification of sitting postures and detection of falls from wheelchairs for the people with mobility impairments. The fall detection and posture identification are carried out with a social robot called MIRob (Moratuwa Intelligent Robot), which receives visual input through a Microsoft Kinect Sen-

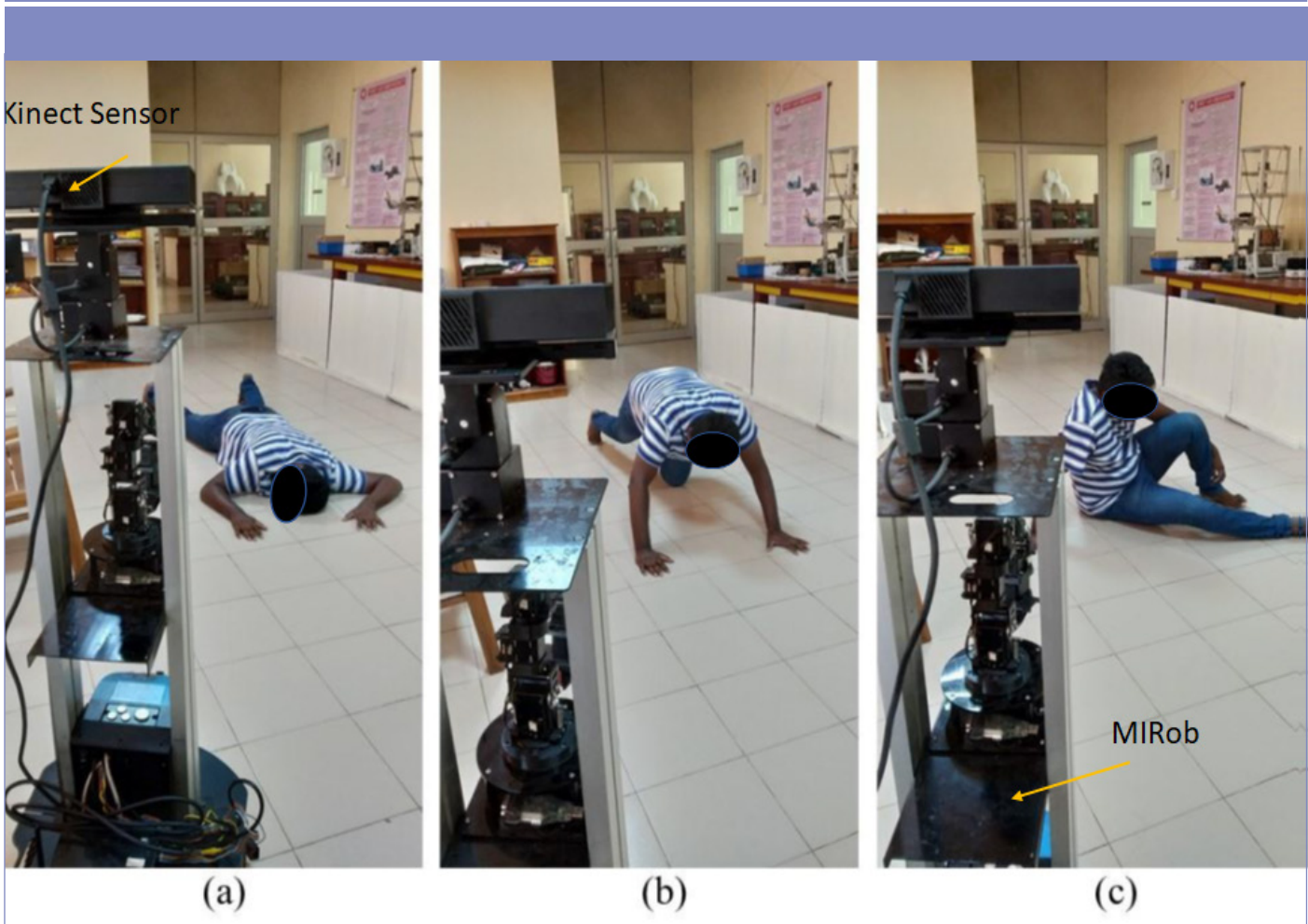
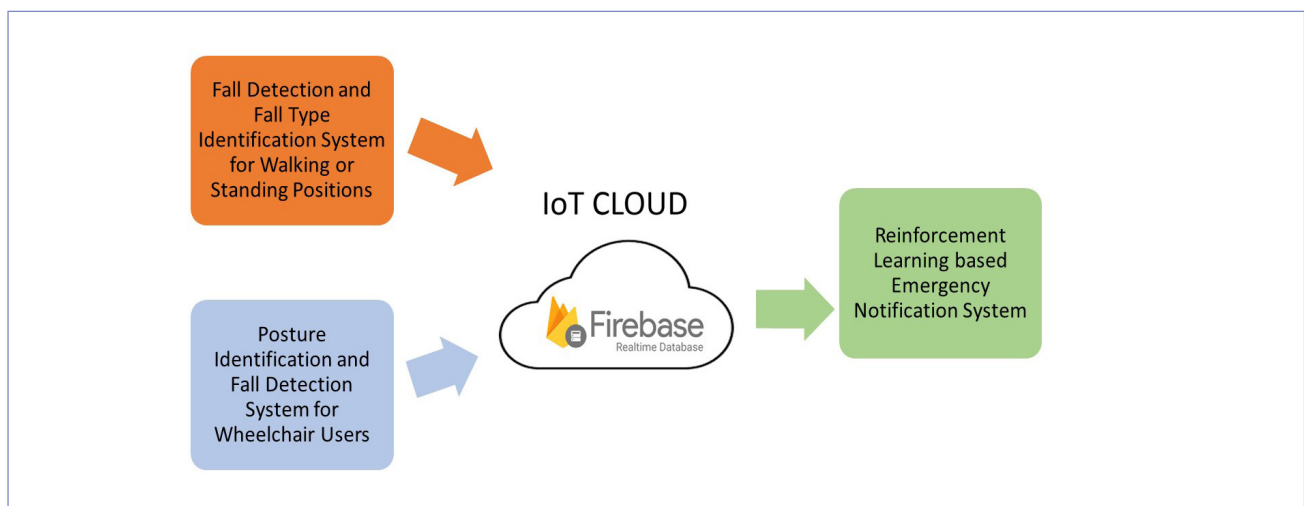


Figure 1: Types of fall (a). Prone Position, (b). Crawl Position, (c). Kneel Position

sor. A novel emergency notification system is also presented where, the notification is performed by implementing a Q-Learning algorithm using a Reinforcement Learning agent via an Android application.

The overall proposed smart home system is shown in Figure 1. It basically consists of three subsystems namely, 'Fall Detection and Fall Type Identification System for Walking or Standing Positions',

'Posture Identification and Fall Detection System for Wheelchair Users', and 'Reinforcement Learning based Emergency Notification System', which are integrated over an IoT Cloud developed using Google Firebase Real-time Database. The three subsystems work together to provide the elderly and the disabled with two main services; Fall Detection and Emergency Notification and promise to offer great support and safety in leading their daily lives.



The functionalities of the three subsystems are described in detail below.

1. Fall Detection and Fall Type Identification System for Walking or Standing Positions

This is a novel vision-based approach of detecting falls using the skeleton data obtained from the Microsoft Kinect sensor. This is implemented in real-time and ensures timely detection of falls. Further, the system overcomes the limitations of the existing similar systems. A fall is detected by considering the velocities of three body joints; Spine Shoulder, Spine Mid and Spine Base, and the orientations of two body vectors; Spine and Femur. A fall is distinguished from an activity of daily living by waiting for 't' seconds, after encountering a 'Transition Period'. Once a fall is detected, it is categorized in to one of the three types of falls; Prone, Crawl and Kneel, which enables more focused medical attention. Example scenario is given in Figure 2.

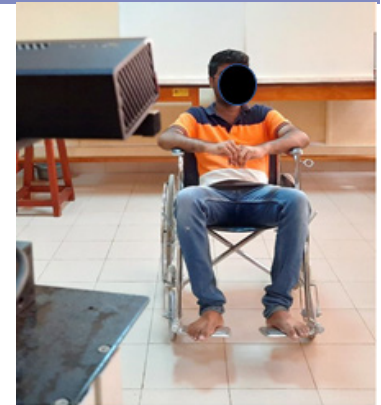
2. Posture Identification and Fall Detection System for Wheelchair Users

This method of posture identification and fall detection for wheelchair users is a novel vision-based mechanism involving a Microsoft Kinect sensor and Vitruvius Framework. This operates in real-time and detects falls quickly and effectively. This system provides solution to the limitations of already available similar systems. The system is capable of discriminating among four sitting postures; Proper Sitting, Lean Forward, Lean Left and Lean Right by considering the angles made by the torso in three directions as in Figure 3. A fall from the wheelchair is detected by observing the distance from waist to floor and the velocity of waist.

3. Reinforcement Learning based Emergency Notification System

This is a novel method of emergency notification using a Reinforcement Learning agent with an Android application. This assures timely notification with a proper feedback mechanism. This system solves the limitations found in other similar systems. The system utilizes two parameters namely, probability of

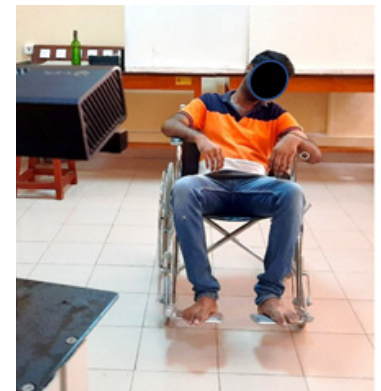
“ Fall detection from both standing and seated positions as well as sitting postures are detected by the system automatically with the help of the service robot MI Rob, where the detection system is capable of automatically triggering the Emergency Notification System ”



(a)



(b)



(c)



(d)

Figure 2: Four Sitting Postures Identified by the System)a). Proper Sitting, (b). Lean-Forward, (c), Lean-Left, (d). Lean-Right

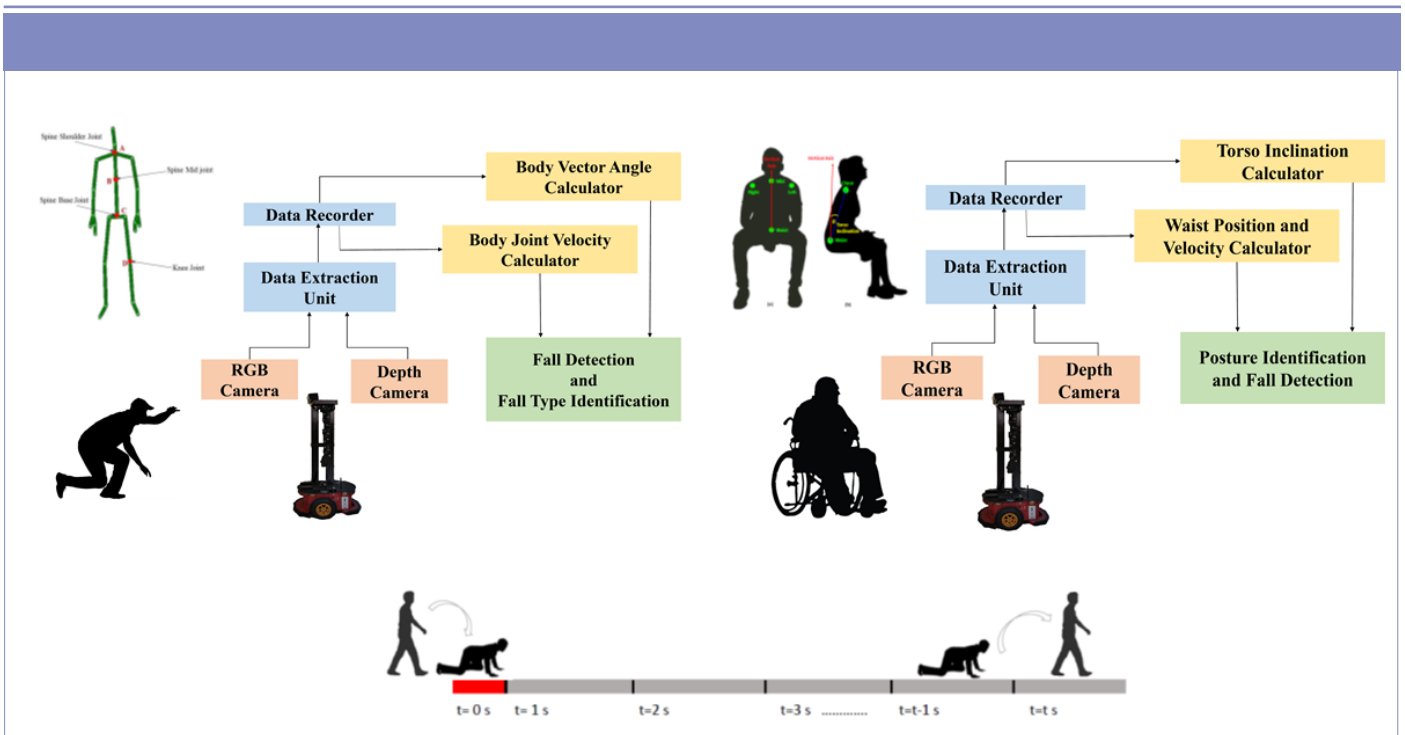


Figure 3: Overall system in detail

answering and level of being busy of the contact persons to come up with an order of calling based on a Q-Learning algorithm. The GPS location data is also taken into account when preparing the order of making calls. As an elder is more likely to become nervous when making decisions during an emergency, this automatic notification system is more effective in notifying emergencies to responsible parties during emergencies.

Fall detection from both standing and seated positions as well as sitting postures are detected by the system automatically with the help of the service robot MIRob, where the detection system is capable of automatically triggering the Emergency Notification System. If the user detects any other emergency that the system cannot identify automatically, then the system provides the user with the facility of signalling the IoT cloud manually by providing an 'Emergency' button in the Android application.

Once the IoT cloud receives an emergency signal either automatically or manually, the emergency notification system starts to operate. Thus, a responsible person will get informed regarding the emergency in time, so that the elder or the disabled person will get support quickly enough to minimize any possible negative consequence.

Through experimental studies the overall proposed system has promised to guarantee acceptable levels of accuracy and timeliness in providing assistance to the elderly and the disabled. Thereby, the proposed overall system is capable of providing the elderly and the disabled with adequate support as well as ensure safety and improve their independence and quality of living.

¹Tharushi Kalinga, ¹Buddhika Jayasekara, ²Indika Perera

¹Intelligent Service Robotics Group (ISRG), Department of Electrical Engineering, Faculty of Engineering, University of Moratuwa, Sri Lanka

²Department of Computer Science and Engineering, Faculty of Engineering, University of Moratuwa, Sri Lanka

Autonomous Vehicles for Urban Air Mobility: Future of Mobility

Urban mobility is evolving with the arrival of autonomous vehicles which contributes for a unique fundamental change. The environmental and social concerns have brought the quest to redesign urban mobility sustainably.

Significance of Urban Air Mobility

Urban air mobility is not a new concept though it drew attention and made discussions in recent years. The current urban transportation infrastructures would not be sufficient to cater to ever-rising population in the world. Urban air mobility has the challenge to address urban integration, acceptance from the public, automated air traffic management, and evolving technological aspects. The modern and rapidly increasing urbanization sights sustainable solutions like electric air taxis, drone transportation for the mobility need. The new perspective for urban mobility is introduced with autonomous air taxi services and autonomous vehicles for freight transportation by flying over cities.



The Global Urban Air Mobility Industry report has mentioned that the urban air mobility market will reach \$12.4 Billion by 2027[1]. The compound annual growth rate in the global market for urban air mobility is expected to grow 9.9% over the 2020-2027 period [1].

Autonomous vehicles are a crucial mode of transportation when it is linked with passengers' trust, willingness to travel, social influences, readiness to use, and behavioral intentions. The passengers' trust contribution mostly describes whether they accept the autonomous commuter vehicle though it values time, cost, and comfort. The risk perceptions, lack of knowledge among passengers can act as challenges when converting passenger mode choice on autonomous vehicles in air transport.

Factors to Consider

According to the European Union Aviation Safety Agency (EASA), autonomous vehicles for air mobility require to consider several factors refer to their design. Safety and security, noise and environmental impact, integration with existing infrastructures, granting approval from governing bodies, and acceptance from the public are these factors. The autonomous vehicles for air mobility are guided and coordinated with an interconnected web of intelligent applications and infrastructures like artificial intelligence or 5G technology.

Urban air mobility contributes immensely to travel time-saving. It requires transforming urban travel while having faster connections with facilities like business, residential, medical, and others. To maintain these connections, air taxis need to integrate with already established infrastructures and fly close to the high-density population areas. In urban air mobility, the infrastructure-related issues and concerns arise with respect to autonomous vehicles. The main infrastructures for passenger air mobility are called vertiports, vertipads, vertistops and skyparks [2]. In the urban city area, some possible infrastructures can be used to facilitate for vertiports such as rooftops of supermarkets, vacant lands, floating barges, helipads, large stadiums, parking lots which are only used for weekends, etc. According to researches, the ideal vertiport loca-

tion will help to maximize population-cumulative potential travel time savings[2]. Further, different vertiport designs and different layouts like linear, satellite, pier impact the capacity concerns of vertiport.

Autonomous vehicles for air mobility can be powered mainly using a battery or electric grid. If the flying time is high missions, the vertiports require a great number of charging stations and also will require many vehicles to cater to the demand in air mobility service. Therefore, the vehicle characteristics like energy consumption level or recharge time directly impact the cost, efficiency, and viability of air mobility networks.

Future Applications in Urban Air Mobility Companies

The increasing demand for alternative transportation modes with less carbon footprint and the need for decongested roads have made the urge for many companies to make innovations on urban air mobility. Airbus has announced its plans in late September to launch a new CityAirbus, a brand new flying taxi. The CityAirbus is expected to fly with a cruise speed of 120km/h within the 80 km range matching it for major city operations. This is fully electric and has four passenger seats flying

“ Autonomous vehicles are a crucial mode of transportation when it is linked with passengers' trust, willingness to travel, social influences, readiness to use, and behavioral intentions ”



with the aim to cover short distances speedy and quietly.

As a true pioneer in delivering solutions for urban air mobility, Volocopters experiment the first public test flight, VoloDrone in Hamburg, Germany in October 2021. The flight was limited to three minutes which reached 72 feet altitude which marked the first-time operation in a public environment. VoloDrone will be built more efficiently and robustly to address existing logistics processes. The invention of autonomous aircraft and the necessary software, infrastructure systems will keep the momentum for Volocopter to initiate commercial flights in Paris and Singapore in upcoming years.

Urban Aeronautics is well known as the developer of the first compact, wingless electric vertical takeoff, and landing (eVTOL) aircraft. In early 2021, Urban Aeronautics experimented with their first flight tests, on flying car CityHawk partnering with HyPoint Inc. which is powered by hydrogen. This innovation is empowered by fan craft-based technology and has high stability and decrease noise. The compact design is efficient enough and ensures to save time which is well capable to land on vertiports in building rooftops. CityHawk has its own ability for safe operation under any weather condition.

The electric air taxi developer Joby Aviation made the acquisition of Uber Elevate from Uber Technologies last year. It is as a part of the deal to integrate services and develop eVTOL passenger aircraft which is aimed to fly in early 2023.

German electric aircraft developer Lilium GmbH is expecting to unveil regional air mobility vertiports in Bavaria positioning in Dusseldorf airport and Cologne airport. The Lilium Jet will travel 186 miles per hour and accompany five passenger seats that help to reduce travel time between regions.

The autonomous vehicles for air mobility will make new opportunities in logistics, public services, development in agriculture, and forestry experimenting in many industries other than the purpose of commuting. The innovativeness, environmental concerns, usefulness of the autonomous vehicles positively impact the intentions of the passengers to move with air mobility.

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Article by

Mahekha Dahanayaka, Amila Thibbotuwawa

Department of Transport & Logistics Management,
Faculty of Engineering, University of Moratuwa, Sri Lanka



Realizing Sustainable Biomass Utilization Through Circular Economy Concepts

Owing to carbon neutrality, biomass is a popular renewable energy source in the global context. In Sri Lanka, a significant portion of primary energy supply in industrial and domestic sectors comes from biomass sources but a sustainable biomass supply chain is yet to be realized. Researchers at the Department of Chemical and Process Engineering are working towards the realization of circular bioeconomy with novel concepts of thermochemical biomass pretreatment technologies.

Flue gas driven torrefaction for a sustainable biomass supply chain

Torrefaction is a thermochemical pretreatment method to increase the energy density of biomass which became a hot topic in the bioenergy research community in the recent past. The process is carried out at 200-300 °C for about one-hour in an inert atmosphere. However, large-scale use of inert gas is neither realistic nor economical, and alternative methods are being investigated by researchers all over the world. The waste heat available in the industrial flue gas at a similar temperature range is best suited as a torrefaction medium. Those industries have a good opportunity to recover the waste heat through the integrated torrefaction process. However, the flue gas generally contains 2-6% oxygen which provides a slightly oxidative atmosphere instead of the inert atmosphere expected in the torrefaction process.

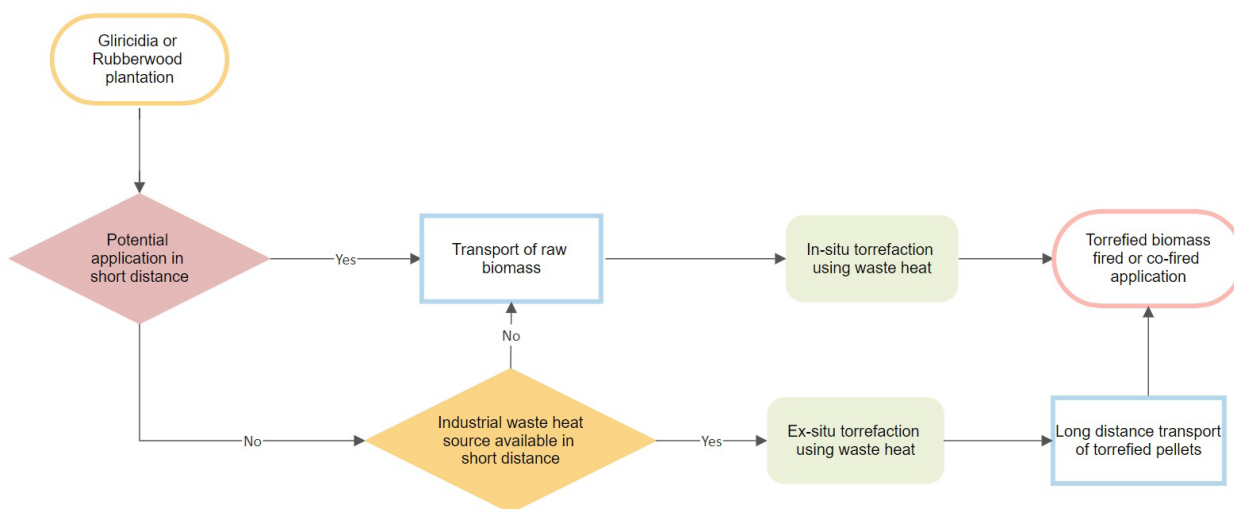


Figure 1: In-situ and ex-situ torrefaction concepts for woody biomass

“ Sri Lanka being an agricultural country, a considerable amount of rice straw and rice husk is annually produced and mostly underutilized. ”

At the Department of Chemical and Process Engineering, we are investigating the effect of oxidative torrefaction for common woody biomass sources available in Sri Lanka, namely Gliricidia and Rubberwood. It is desirable to achieve high energy yield along with less mass yield for the improved energy density of biomass. Therefore, the effect of torrefaction temperature, residence time, and oxygen content in the torrefaction medium is being investigated in a lab-scale torrefaction reactor and the optimization based on energy-mass co-benefit is being carried out. With successful implementation, industries with flue-gas waste heat can be benefitted by producing torrefied wood pellets as a value-added product. On the other hand, industries with biomass-fueled dryers, heaters, boilers, and furnaces can also be benefitted by replacing raw

biomass with torrefied biomass due to improved combustion process and reduced logistic costs. Improved energy density results in reduced transportation cost and improved hydrophobicity makes open-air storage feasible. Further, torrefaction makes preprocessing easy and less energy-intensive due to improved grindability.

The concepts of in-situ and ex-situ torrefaction are demonstrated in Figure 1. If the potential application is within a short distance, transportation of raw biomass and in-situ torrefaction at the application site would be feasible. Else, ex-situ torrefaction at a waste heat source available in a short distance would be beneficial. In either case, the circular bioeconomy concept is realized due to the use of waste heat in the flue gas.

Combined pretreatment of agricultural waste for better ash chemistry and energy density

Sri Lanka being an agricultural country, a considerable amount of rice straw and rice husk is annually produced and mostly underutilized. This is mainly due to high ash content and low energy density that hinder the effective utilization of those in combustion applications. Even though, torrefaction increase the energy density of agricultural waste, a challenge remains because of the large

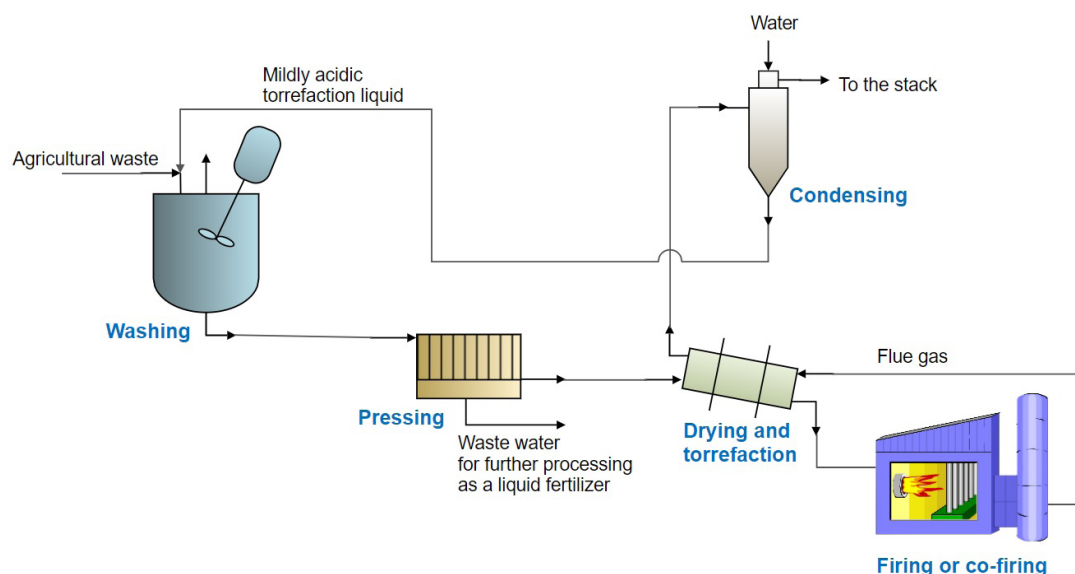


Figure 2: Combined pretreatment concept for agricultural waste

amount of inorganic minerals remaining in the torrefied product. It is well-known that alkali metals in biomass have significant impacts on subsequent applications. Mainly alkali vapors react with silica to form alkali silicates causing major sintering and fouling problems. The presence of chlorine results in the formation of alkali chlorides which are highly corrosive and melting on superheater metal surfaces is problematic. In addition, alkali chlorides remain in flue gases may form particles making fly ash more corrosive. Water washing is an effective pretreatment method to remove such troublesome elements from biomass. After years of research on washing and torrefaction as separate pretreatment options, nowadays the focus is on combined pretreatment of washing and torrefaction considering the positive effect of both pretreatment methods. This process plays a vital role in the pretreatment of agricultural waste such as rice straw and rice husk.

The liquid byproduct produced during torrefaction mainly contains water and organic acids (mainly acetic acid and formic acid) and dilute acid washing using this torrefaction liquid product is considered to be an effective pretreatment technology. Further, mineral-laden wastewater can be a source of liquid fertilizer with necessary upgrading. Figure 2 represents the concept of such com-

combined pretreatment technology considering industrial installation.

At the Department of Chemical and Process Engineering, we are working on optimization of combined washing and torrefaction pretreatment parameters including pre-washing and post-washing options for ultimate application of agricultural waste as combustion or cofiring feedstock. The optimization is based on energy densification, fouling, slagging and corrosion propensities, and combustion reactivities.

Findings of the studies done so far reveal that pretreatment technology is of utmost importance for making biomass a sustainable resource. Circular economy concepts can add extra value to the sustainability of the bioenergy sector while making the pretreatment process more economical and could play a major role in making local industries more resilient towards fuel switching which is inevitable sooner or later.

Article by

Duleeka Gunarathne

Department of Chemical and Process Engineering,

Faculty of Engineering, University of Moratuwa, Sri Lanka

Scholarly Output: 2015 ++

A single slide from a presentation entitled "Research Outputs of Sri Lanka and How Expats Can Help" by Prof. Saman Halgamuge of the University of Melbourne, in June 2021 sparked interest among the University of Moratuwa community. This slide reproduced as Figure 1, shows the University of Moratuwa moving from one league to another in respect of Scholarly Output during the period 2015 – 2020. A passing remark by me about possible influencing factors made the Dean, FGS pursue me relentlessly until I wrote this article.

So what factors caused the something positive that happened to our publication trend 2015+ ?

In what quantifiable ways have these factors contributed ? **Are we happy ? What next ?**

Prologue: The few years prior to 2015 were a time of reflection. The previous decades had seen the University battered by the fallouts of civil war, political instability and social unrest; losing academics, random closures, and research surviving under the most difficult of circumstances. Nevertheless, the UoM flag was flying ever so high, along with the reputation of its graduates. The backlog in undergraduate intake was almost cleared. Academics had won a struggle for more government investment in education. With the promise of a good quality of life, young people with PhDs from world-renowned universities had started returning home. The enthusiasm for research among staff and students was increasing. It was time that we started moving from being a traditional teaching University to one excelling in research and innovation!. Consequently, a thrust for enhancing the research culture surfaced in the Corporate Plan 2010 – 2015 and the Strategic Management Plan (SMP) 2014 – 2018. The stage was set. I try to present below some facts and figures surrounding the plan implementation and some outcomes.



“ The enthusiasm for research among staff and students was increasing. It was time that we started moving from being a traditional teaching University to one excelling in research and innovation ”

One of the first strategic initiatives was the creation in 2014 of the position of **Director/Research**. The **Senate Research Committee** (SRC) which managed internal research funding was strengthened under the guidance of the Director/Research with generous grant allocations from the University's coffers. In this, the University tried to follow UGC's Finance Circular 1/2013 recommending 10% of the annual capital allocation to research. The monthly **stipend for Research Assistants** was increased by 50%. Following the University of Moratuwa, the same stipend increase was subsequently adopted by the National Science Foundation (NSF) and the National Research Council (NRC), thus benefiting

the entire research community in Sri Lanka. The SRC went on to revamp the reward mechanisms for research outcomes. The evaluation criteria for the University of Moratuwa **Awards for Outstanding Research Performance** were amended several times, raising the bar on the quality of publications as well as introducing awards at different levels. Despite the raised bar, the number of awards increased each year. Recognizing that no matter how good the research is, quality publications cannot always materialize without further financial support, the SRC then initiated **Publication Support** Grants scheme with associated criteria to meet the cost of (open access) journal publication, conference registration and international travel ⁱⁱ ⁱⁱⁱ. Figures 2 and 3 show respectively, the allocation of different grant schemes of the SRC, and the number of awards made for research excellence during 2015 – 2020

A new **Faculty of Graduate Studies** was on the cards in the SMP. Difficulties of managing an increasing number of research students, and the need to grow further were evident. The Faculty was established in 2015, following an year-long discussion on the wisdom of doing so. Its mandate included streamlining the administration of research degrees, promoting collaborative and multidisciplinary research and creating better visibility for UoM research. Seven **Multidisciplinary Research Centers** were established in 2017. The objective was to strengthen areas where synergies could be derived through collaboration across Departments and Faculties. In another unprecedented move, the University coffers provided seed funding of Rs. 35 Million for the first two years. Many centers proceeded to secure significant external funding subsequently as expected of them. To match and support SRC's evolved awards criteria and publication support, **publication requirements** for research degrees were tightened. A framework for offering joint **PhD programs** with overseas universities was established. So were **fully industry sponsored PhDs**. The ensuing years saw the enrollment in postgraduate research programs rise, particularly in the full-time mode ^{iv}. The graduating numbers followed, as illustrated in Figure 4.



Digital Resource	2015		2016		2017		2018		2019		2020	
	Cost (USD)	Usage	Cost (USD)	Usage	Cost (USD)	Usage	Cost (USD)	Usage	Cost (USD)	Usage	Cost (USD)	Usage
ACM Digital Library	6,329	2,931	6,547	2,658	6,879	2,992	7,273	4,950	7,630	3,874	7,847	1,415
Emerald DB	**	18,778	**	31,108	**	29,304	**	21,488	**	14,220	**	11,766
IEEEExplore Digital Library	56,395	10,175	54,312	23,950	53,770	61,463	55,000	69,740	53,230	87,343	54,830	30,352
Science Direct	69,210	46,162	49,474	44,777	51,948	68,414	55,296	82,547	58,452	49,969	61,811	34,946
Scopus	NS	NS	18,000	17,534	19,080	18,138	20,224	19,863	21,438	26,342	NS	NS

** : Subscribed by UGC NS: Not subscribed Usage: Number of Searches (Scopus), Number of full-text downloads (others)

Table 1: Investment in digital libraries and databases (2015 – 2020)

MERCon^v contributed in no mean measure. Originating as the annual symposium of the Engineering Research Unit (ERU), its objective was to provide a venue for first time publishers and early career researchers. The event grew in stature over the years. In 2015, its 20th year of existence, the symposium transformed into MERCon, the flagship conference of the University that it is today. Since then, MERCon has gained entry into

the IEEEExplore digital library, and hence indexed by Scopus. Today, MERCon accounts for 23% of over 2700 University of Moratuwa - authored publications listed in Scopus since 2015. Of the total 1841 publications credited to the University in IEEEExplore, MERCon accounts for one third. It has achieved an h-5 index of 17 as per Google Scholar Metrics. MERCon has come a long way, spurred on by the dedication of successive self-motivated

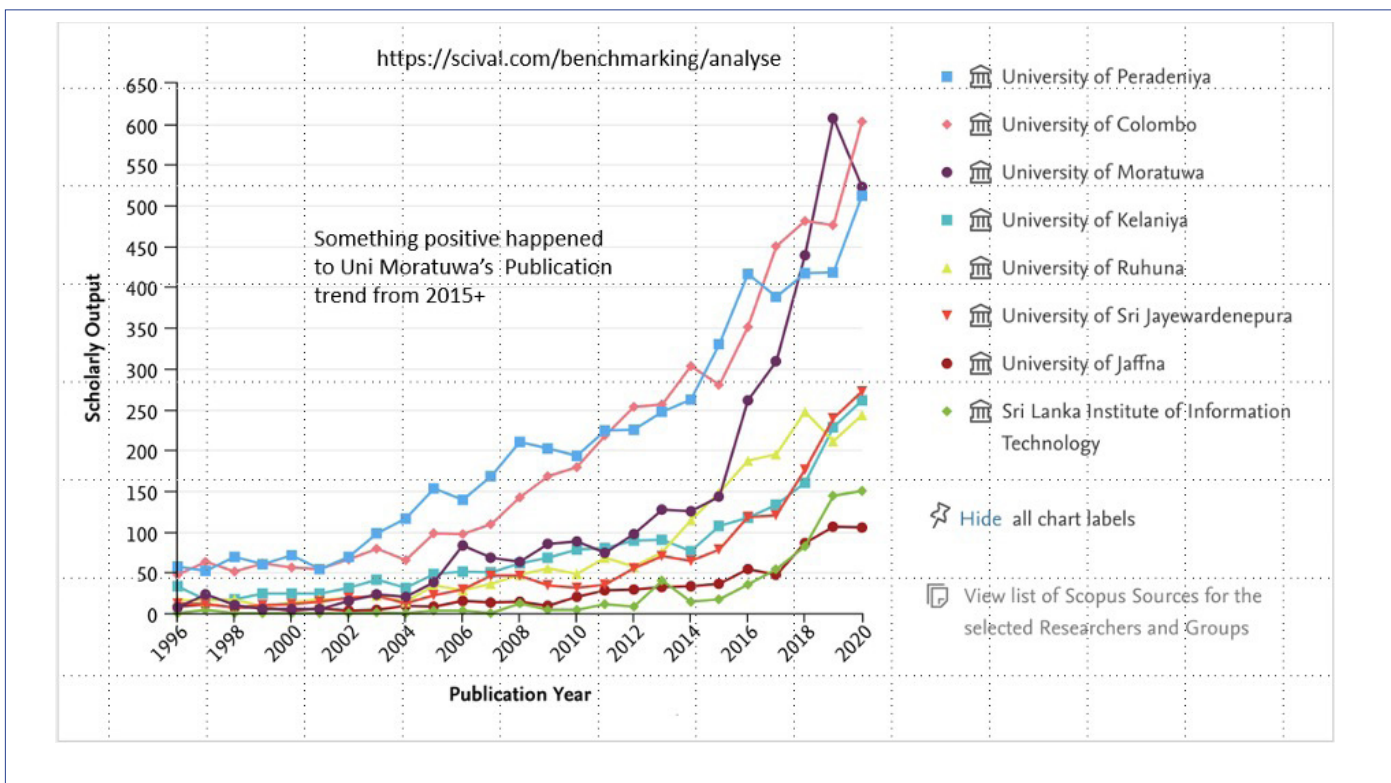


Figure 1: SCIVAL Comparison of 9 Sri Lankan Universities [Courtesy: Prof. Saman Halgamuge]

teams. Faculties of Architecture, Information Technology and Business have strengthened their Research Units as well, and hold annual conferences which are growing.

This story is not complete without the **Library's** role. Research could not have progressed without current publications from around the world available at the fingertips of our researchers. Table 1 speaks for itself about the investment made on **subscriptions to digital libraries and databases** during 2015 - 2020, and the corresponding usage by the University community^{vi}.

There go some possible answers to **What factors?** and **In what quantifiable way?** Though a formal analysis is not within the scope of this article, changes of the post-2015 years are evident.

So, are we happy? We should definitely be, of the efforts and the rewards reaped so far. The lessons learnt are that different facets of the problem to be solved were identified and a multi-pronged, yet coordinated attack was launched. Bold decisions were made administratively, financially and academically. Entities and people worked for a common goal. These have paid dividends, not only in Scholarly Output, but also in making a change in the broader ecosystem for a better future.

What next? Now let us look at Figure 5. Despite not comparing apples to apples exactly, it is evident that we have a long way to go. Further, a breakdown of the 1841 publications in IEEExplore shows 96% (1773) conference papers, and 3% (61) journal papers. Scopus statistics are kinder, with the percentage of journal publications moving from 30% to 35% during 2015 - 2020. The stature of conferences vary widely as do that of journals. Nonetheless, we still have a long way to go. While the described strategies have worked, continuous improvement is the key, and the space for improvement is vast. Examination of Figures 2 and 4 would show directions for more productive resource distribution. Pushing old strategies up notch by notch is one way forward. Some bold new strategies would not

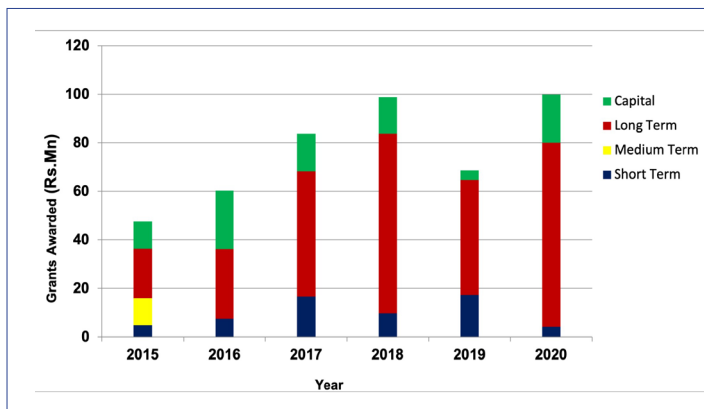


Figure 2: SRC research grants awarded (2015 - 2020)

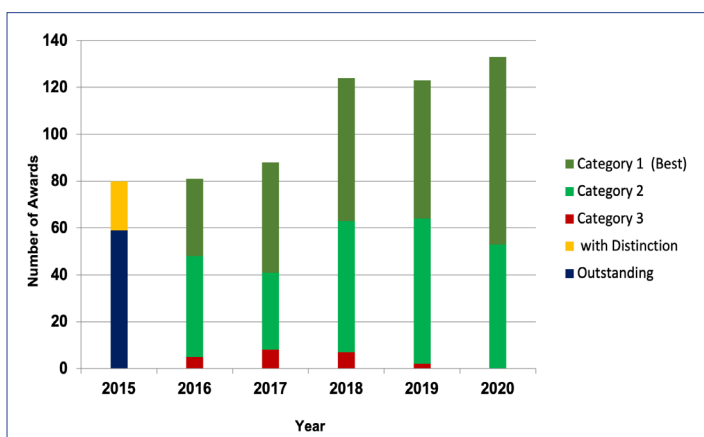


Figure 3: Awards for Outstanding Research Performance (2015 - 2020)

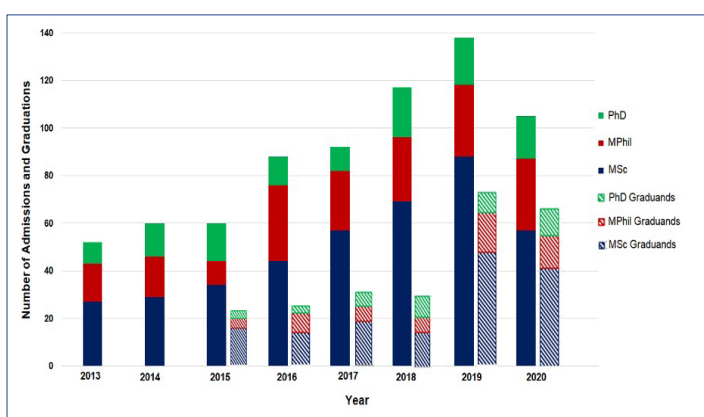


Figure 4: Postgraduate student enrollment and degrees awarded (2013 - 2020)

be too bad either. The need for attracting high-caliber research students and external research funding are ever-present. More multidisciplinary research and collaboration with more established researchers are proven to work. The Faculty of Medicine will have an important role to play. COVID-19 dealt a bad blow. We do not know how deep or for how long it would be felt. The impact on 2020 is already seen, and a recovery plan is a must.

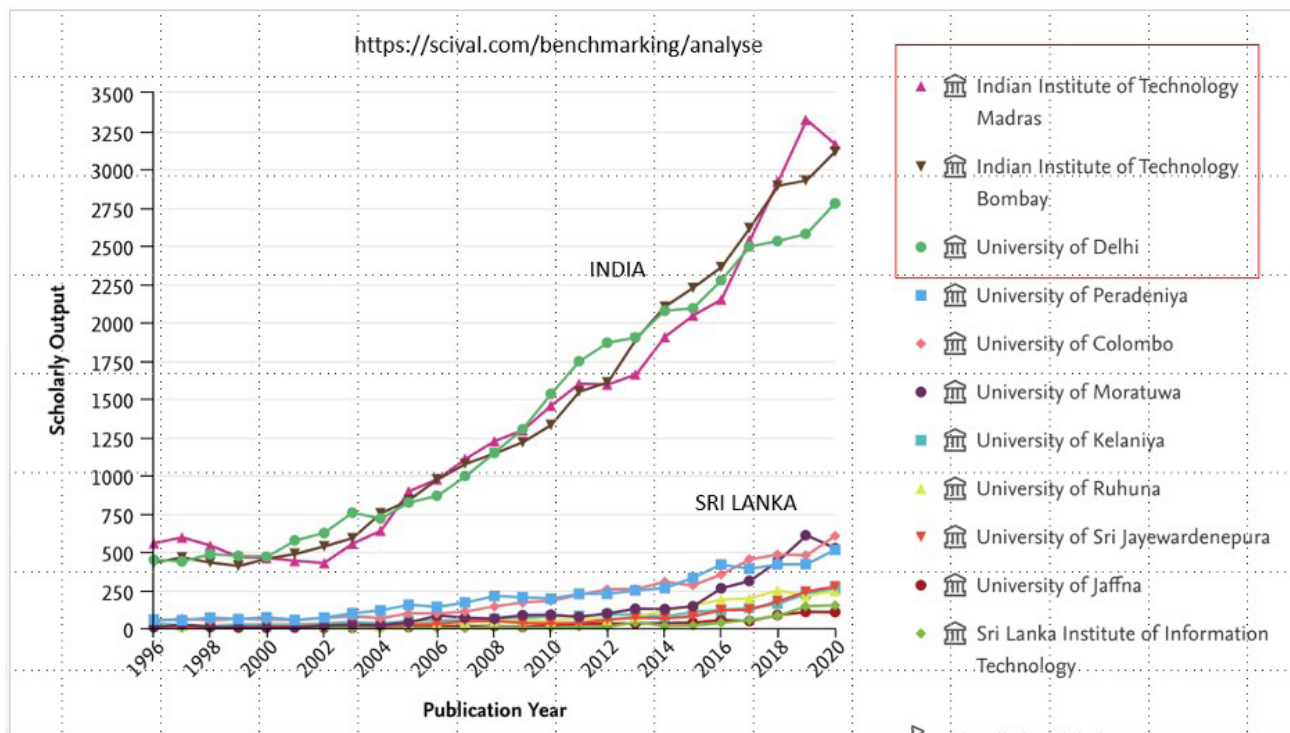


Figure 5: SCIVAL comparison of 3 Indian and 9 Sri Lankan Institutions
 [Courtesy: Prof. Saman Halgamuge]

Epilogue: At the end of the day, what would be the true impact of our research? For some prestigious universities, research is for ranking, then for attracting students and become profitable enterprises, perpetual machines. For some others, it is for the advancement of knowledge that makes a difference to the way we live. Their positions are assured regardless of any ranking system. Where in this spectrum, do we aim for?

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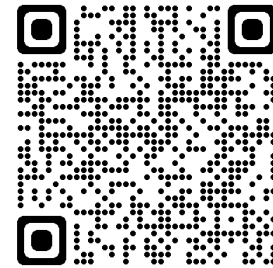
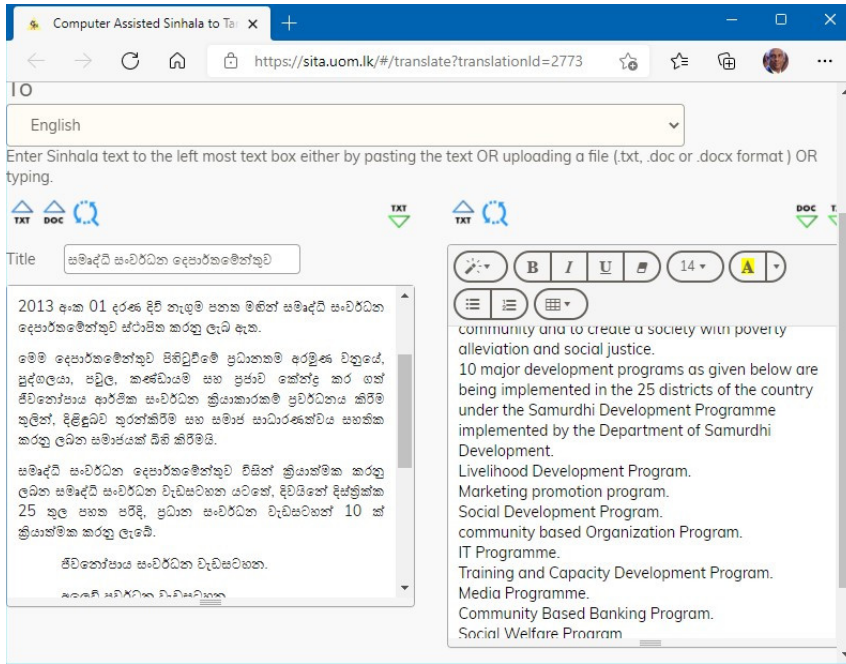
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Article by

Dileeka Dias

Former Dean, Faculty of Graduate Studies, University of Moratuwa
 Department of Electronic & Telecommunication Engineering
 Faculty of Engineering, University of Moratuwa, Sri Lanka

The SiTa Trilingual Translation System



The National Languages Processing Center (NLPC), at the University of Moratuwa has been developing the SiTa Computer-Assisted Translation System since 2018.

Government organizations need to produce official documents in all three languages – Sinhala, Tamil and English. So far this had been a manual process, by human translators. Hence, the scarcity of the human translators had been a bottleneck for these organizations, in producing the trilingual documents at the expected rate. Identifying the gap and the timely need, 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 among Sinhala, Tamil and English.

SiTa uses a state-of-the-art neural machine translation engine to translate document. This translation is then checked and corrected by a profes-

sional translator and finally verified by a reviewer. We have improved both the accuracy and speed of translations with this three-step process. We also maintain the confidentiality of your documents.

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

- circulars
- reports and
- letters

For more information, please visit:
https://www.uom.lk/nlp/news_events/professional-translation-service
 or e-mail sita@uom.lk .
 A video introduction is at
<https://youtu.be/WQVJg0HxjG0>

Article by
Thanuja Perinpanathan, Gihan Dias
 The National Languages Processing Center (NLPC),
 University of Moratuwa, Sri Lanka

Manual Work Assistance for Outdoor Home Gardening for Adult in Semi-urban Household

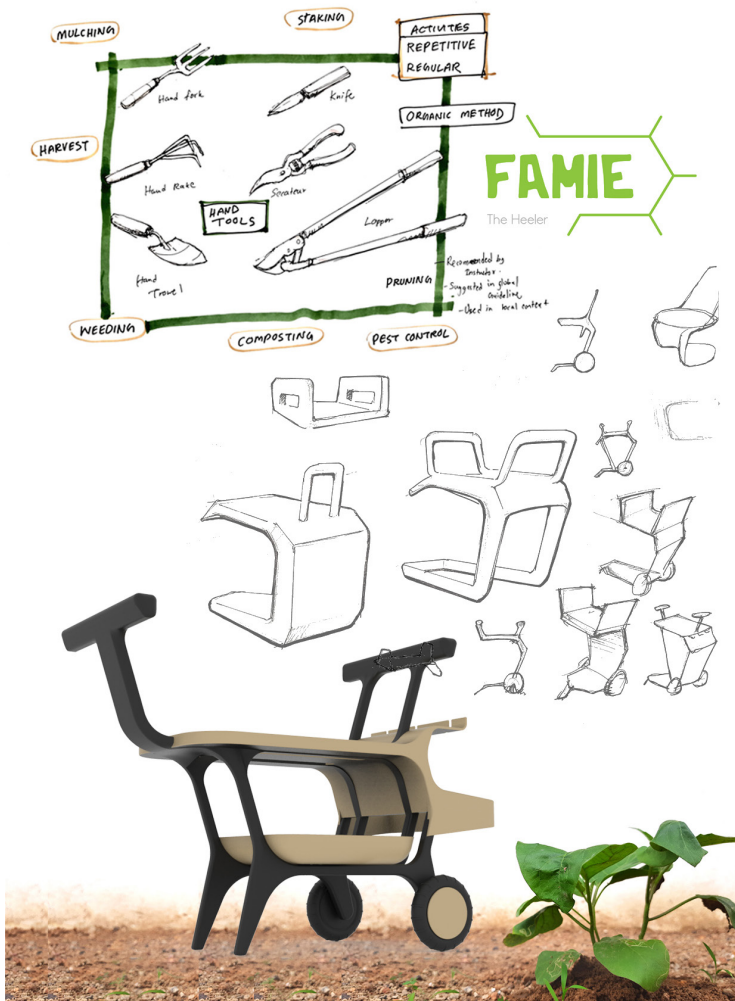
Sri Lanka has been suffering from triple burden of malnutrition crisis for past years[1] and the global reports have denoted the lack of growth to overcome this matter[2]. Covid 19 pandemic has become a viral threat to every socio-economic platform, establishing majority of human preference to spend the time at home and to consume the products made at home. The comfort and safety related implementations have become the most chosen of the people who used to be normal at home[3]. The status of health, wellbeing, sleeping patterns and quality of life were changed because of the restricted mobilization took place during the pandemic period dragging energy expenditure and dietary into a critical situation[4]. Around 70.2% people were accepted the advice of 'stay home' and it has resulted both positive and negative consequences in the lifestyle[5]. A larger proportion of the population who experience extra time at home have started planting essential crops in their home gardens according to the day-to-day needs. The organic practice has raised as a potential method to follow from scale gardens. Even different authorities have already conducted sharing technical information to promote and discuss home gardening as it supported to heal the basic needs[6].

I identified a group of people who have a great interest in gardening in every part of the country. Some of them have enough space in the lands and some of them do not. They have been engaging in home gardening for a long period of time even before the pandemic. The people in semi-urban regions have arranged land space around the house more intensively than before because of the need to produce vegetables and fruits without buying them from outside. It has showed economic ben-

efits for the middle-income community and a satisfaction to enjoy nutritious high-quality food. They started transforming the situation of staying home towards satisfaction by growing vegetables, fruits, flowers, and many varieties of crops. The manual performance in the garden helped physically and mentally to maintain a good health condition.

I identified above 35 years old women who have a great interest in outdoor home gardening in the current context. Specifically, the role of mother in such household is engaging with more repetitive and regular activities such as mulching, staking, and weeding in organic outdoor practice. She is suffering from mild musculoskeletal conditions

“ A larger proportion of the population who experience extra time at home have started planting essential crops in their home gardens according to the day-to-day needs.”



and keep engaging in home gardening while adapting to the 'new normal'. I identified the inability to manage and minimize the excessive manual effort required in organic farming activities as the key challenge to overcome. The struggle is associated with managing the activities, tools, techniques, and physical difficulties of the body during the hours of working in their narrow spaces of 15 perch land slots. I figured out that they face rapid fatigue when exposed to static postures at certain postures such as bending and kneeling. According to the observations the consequence of this problem has been resulting the negative experience to the person.

I identified 6 most important tools: hand trowel, hand fork, hand rake, secateur, knife and lopper at the end of a focused survey concentrated on a region where home gardening is potential, and the need of nutrition intake is high. I identified suitable ergonomic approach for assistance facility combined with the features to support arms at postur-

al transitions and rapid tool storage with the intension of coming up with a product solution as an assistance for outdoor home gardening activities at a particular terrain condition.

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Article by

Praneeth Perera

Product Design,

Department of Integrated Design, Faculty of Architecture,
University of Moratuwa

BOLGODA CHAT

The Teaching Vice Chancellor

An interview with
Prof. (retired) GTF De Silva

The early years

When I think of my early days, there are two experiences that made a profound influence on my future career. My father was an Assistant Station Master, and he taught me all aspects of managing a railway station except telegraphy. Later, as my father became ill, my parents arranged accommodations for me in a house near the Ulapane station and left for our home in Ambalangoda. Occasionally, the station master used to consume alcohol during night shift, and he used to summon me to look after the station. At 10 years of age, I handled all the functions of a railway station including tablet operations, advising the cabin man on signaling, issuing tickets, and informing the transport office based on train numbers. My main problem was waking up the SM from his deep sleep when an express train approached, placing his cap on the head, and taking him to deliver the tablet to the driver.

After my father passed away, we moved to a small house owned by my mother's family and lived on the meager pension my mother inherited. Later, we moved to a better house with electricity, pipe born water and even a radio set. I used to help some neighbours who were obsessed with betting on horse races, by translating the radio commentaries and race books. I soon became an advisor on horses and jockeys even though I never placed any bet. Around 14 years of age, I had become the chairman of a youth club, started a library at our home, commenced a hand-written magazine, and started doing religious and social work. During our activities we had to clash with families consisting of known thugs around our village. I used to address some of them who were known killers as "aiya", and later in my life, this helped me in working with some "academic thugs" (laughter)!

My school education up to SC (equivalent to O/Level) was at Dharamasoka College, except for six months at a school near Ulapane. My school did not have the provision for HSC (equivalent to A/Level) in the science stream. In my search for another school, I was rejected by seven schools. Finally, having admitted by the Richmond College, I passed university entrance with distinctions winning the Darrel Medal as the best student that year. I also won the Galle Gymkhana Scholarship as the best student of the Southern Province.

I spent four years at the University of Colombo doing a Mathematics Special degree. That became the most boring period in my life. My boredom led me to make the mistake of joining a left wing political movement. Yet, I somehow managed to secure a second-class degree to enable me to join the Ceylon College of Technology (CCT) as the very first lecturer.

When I came to Katubedda, I was directed to an office where two gentlemen were seated. I approached the person who looked less violent. That gent later I learnt was Mr. T.O.P Fernando, Principal of the Institute of Practical Technology (IPT). He directed me to Mr. L.H. Sumanadasa, who was Director of the CCT. He greeted me with a Neil Armstrong like statement, saying "At last, somebody has come!" I was introduced to Mr. Muller, the Chief of the UNESCO team and to Professor Funk who was in-charge of the subject of Mathematics. The two UN experts took me to show the foundation of the building now named after the great Sumanadasa. Later, CCT and IPT were combined together.

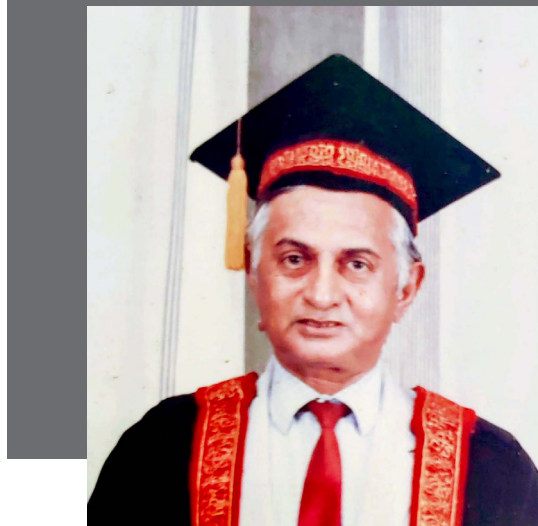
Five of us were sent on UN Fellowships to do post-graduate studies and all of us preferred UK, and I was placed at Imperial College, London. At the end of the second year, we were asked to come home due to the 1971 insurgency. However, I was able to receive my MPhil, as well as obtaining my MBCS and C.Eng.

On my return, I found that the CCT had transformed to a University, with many Professors from Peradeniya and Colombo taking main roles. I became the president of the Buddhist Society and the Staff Welfare Society, and also held the positions of secretary and subsequently president of the Teachers Union. Student Union chose me as their Senior Treasurer, and I had to become involved when the University administration and students faced problems due to race riots, the murder of a student, ragging issues, and a notorious hunger strike.

They made me the Vice-Chancellor

The 1988-1989 was the worst era at the University of Moratuwa, which culminated in the assassination of the Vice Chancellor, Professor Chandra Patuwathavithana and the Chief Security Officer Mr. Upali Ranaweera, while attending to their duties. The University was in turmoil, and no one was willing to assume the role of Vice Chancellor. Ultimately, the Registrar called a meeting of the senior staff, and I did not attend this meeting saying "when the king is dead a crown prince should take over." There were several staff members more senior than me, and I received a notice from the Registrar, giving names of seven staff members who each had to act in the role of VC for one week. My name was the last on this list. We called this era the 'Sath Sathiya' (seven weeks).

Due to a request from some staff members, I had to take over in the third week as the VC and continue for several weeks. During my turn, the Buddha statue erected in the premises was declared open, and this was a great blessing for me. At this time, a search committee had been formed to look for a person willing to make



Prof. (retired) GTF De Silva

"I passed university entrance with distinctions winning the Darrel Medal as the best student that year. I also won the Galle Gymkhana Scholarship as the best student of the Southern Province."

Early days of Prof. (retired) GTF De Silva ▼



the sacrifice and become the VC, and this committee approached me. I had a short answer for them; "I am neither eager nor afraid" to become the VC. One evening, the two Deans, Engineering & Architecture, visited me at my home. They wanted me to take over the vice-chancellorship. I said, "come, join me to watch Woody Woodpecker cartoon on TV". They somehow persuaded me, thus eventually I accepted the offer. My philosophy was "Bahu



jana hithaya, Bahu jana Sukaya," (well being and happiness of many people)." However, I had one condition in accepting this position, and that was, I should be free to continue teaching.

Thus ended the "sath sathiya", and I worked in this role for six years plus one more year. The 'sath sathiya' turned out to be a "sath wasara" (seven years). I continued teaching during and beyond! When I meet my former students, they fondly recall "numerical methods" lessons. The jokes I cracked to break monotone, they had nicknamed "VC's advertisements".



My role as the Vice Chancellor

I can now say, it was a blessing that I had no practical experience in management nor followed a single lecture of that kind. However, I had extensively read about great personalities. Moreover, I had read several books on university administration as a junior academic. The first thing I did was to develop a plan for the University and a plan for my conduct.

During my tenure, the library and hostel buildings were completed, and hostel facilities were provided for female students for the first time. A bank branch, a book shop, and a childcare center for the staff and neighbors were started. The university press, which was running at a loss, was closed and the building was converted to a drawing facility. Many services were rendered to the society, through activities such as regional and school seminars, regional development plans, and road development etc. I have described various activities conducted under my leadership during this seven-year period in a book written in Sinhala, 'Upakulapathi Mathaka Satahan' (Memoirs of a Vice Chancellor).

During my sixth year of tenure, arrangements had to be made for a new VC. Even though the position was advertised in the press and the University Council sent three names to the UGC, the government made no appointment. Instead they kept extending my service. From my end however, I kept pressing the UGC to find a replacement. At the inauguration of the Sabaragamuwa University held around August 1996, I met the Minister himself and made the request. His answer was, "professor, you're doing well. Please continue in acting capacity". I am a man of principles and disagreed with the minister. Finally, I succeeded to being my seven years long vice-chancellorship to an end.

Other memories

LEARN: Around 1990s, a young lecturer with a PhD in electronic networking came to my office with the Registrar. The lecturer wished to introduce the internet, by incorporating all the Universities and Research Institutes to an electronic network called LEARN, and to introduce e-mail system to start with. The Registrar's anxiety was that the staff of all the universities will use this service and we may have to pay a huge telephone bill. Ultimately, I allowed this on a provisional basis for three months. Today, the use of the internet, smart phones and electronic social media are commonplace in all universities.

Nuga Tree: One day, I got a phone call that the Nuga Tree near the L-Block had fallen. Despite the place is usually crowded with students and vehicles, the tree hadn't touched the slightest of them. This Nuga tree

had a history. Many wouldn't know, the "L-Block" was thus named because of this tree. A square building was planned, hence the tree was supposed to be removed. The first day, the machine brought to remove the tree broke down. The next day, the driver got injured and he refused to continue the task any further. Mr. L.H. Sumanadasa, the Director, changed the design to spare the tree. New building was in "L" shape. Not stopping there, he constructed a wall around it. I wasn't a witness, but the elderly security officer who related this story to me, was. At the time of the falling of the Nuga Tree, there were problems in the Campus and Wesak was approaching. I asked the maintenance staff to clean the area and colourwash the wall. On the Wesak day, I went to the Tree, did a simple Pooja, asked the blessing of spirits if any, to bring peace to the Campus. Then unfolded the miracle. The fallen tree that had been trimmed approximately 20 feet from the root, had become upright on its own. While the tree was standing up, a worker who was chopping the branches were on it. Being a great admirer of the tree, I couldn't help writing a poem about this.

The CAD CAM centre of the Department of Mechanical Engineering was opened during my time. I retired from the Department in 2001. However, I did some visiting lectures until recently. I also served as the chairman of the Ceylon German Technical Training Institute.

Indeed a miracle
Risen from the dead
Shedding hair of leaves
You have raised your head

Did you defy gravity
The math we taught
Or did nature help you
On scientific thought

Bless you mother giant
We have shed our gloom
May you live many ages
Grow strong and bloom

Most people have now forgotten that there lived another great 'Tree' that gave shade to the University fell sometime back. That was Arthur C. Clarke.

Now I am a writer

Now I am 84, happily spending time as a writer. I wrote a few detective stories for children connected to places I know such as Rambukkana, Ambalangoda, Ahangama & Weligama. The book on Sir Arthur C. Clarke in sinhalese had gone to the third edition. Translation of the Life Story of His Holiness Dalai Lama is to be released soon. I just completed translation of His book on Inter Religious Harmony. A novel in sinhalese "Happiness for Many" is with another publisher. The book "Experiences as VC" is a gift I give to any one visiting me.

Future direction for the UoM

I strongly feel that we must break away from the UGC and become an independent entity similar to the Indian Institute of Technology (IIT). Prime Minister Nehru created five IITs as he was not happy with the way Indian Universities functioned. He chose to keep IITs under him. They are now ranked among the best of that kind in the world.

When I first joined the CCT, which was created under UNESCO/UNDP, the leader of the UN team was a member of the team that set up the IIT at Calcutta. Even my subject of Mathematics was taught with a practical bias. I strongly believe that we have to produce practical engineers who help the man on the street, as Sir Arthur Clarke told a US committee on science applications.

Steps should be taken to bring more public awareness of the projects that will benefit ordinary people of our country. The people need to see solar and wind energy, low-cost housing projects, and other innovations that make their lives better that are built by the University.

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BOLGODA CHAT

Interviewed & transcribed by
Hirushie Karunathilake & Sanjeeva Witharana

MULTI-HAZARD EARLY WARNINGS;

The Importance of Managing Stakeholders for Effective Disaster Response



Stakeholders in Disaster Management are those individuals or organizations that may contribute to, be affected by or can be influenced in all the phases of the disaster risk management cycle [1]. They can be government agencies, private organizations, media, NGOs/donors, emergency insurers services and the public. There are various fundamental roles that disaster risk management stakeholders have to fulfil in mitigating disaster prevalence. Hazards do not occur in isolation and two or more can be overlapped at the same time. Therefore, disaster management mechanisms should be equipped with adequate preparedness and response capacities. In this regard, Multi-Hazard Early Warning (MHEW) Systems play a vital role.

In most cases, official institutions and organizations disseminate the early warnings while the general public is mostly at the receiving end. However, MHEW systems must be multi-directional, multi-dimensional, and multi-sectoral. For instance, most updated hazard/disaster information has to be obtained from the affected or at-risk communities to enhance the level of preparedness for effective emergency response. This will enable responsible authorities to grasp the real scenario at the grass-root level and distribute disaster-related information accordingly. Furthermore, the coordination between stakeholders such as officials is also paramount for a MHEW to be effective.

Managing Different Phases of Multi-Hazard Early Warning Systems

A Multi-Hazard Early Warning System can be broadly classified into three main phases named: upstream, interface, and downstream [2]. In general, monitoring, detection, and prediction of hazards occur at the upstream phase. The downstream phase consists of the process of disseminating early warnings and evacuation orders to at-risk communities. However, the decisions of issuing warnings and orders take place at a phase between upstream and downstream phases, called the interface. Stakeholders of these phases range from international co-operations at the upstream to local actors and at-risk communities downstream. National agencies and local actors carry out activities in the interface phase. Therefore, altogether there are many stakeholders engaged in this MHEW process. A study carried out by the Disaster Risk Management research team of the Department of Civil Engineering, University of Moratuwa has developed a conceptual framework to illustrate the stakeholder behaviour of the MHEW mechanism in their respective phases in the disaster management cycle [3]. As shown in Figure 1, activity flow among stakeholder levels has been sequenced and mapped against time. The developed conceptual framework was applied to two disaster scenarios that occurred in Sri Lanka for illustration purposes; 1) Indian Ocean Tsunami 2004 and 2) Meethotamulla Garbage Dump Collapse 2017 (see Figures 2 and 3).

Target-F of Sendai Framework for Disaster Risk Reduction [SFDRR 2015-2030] highlights the paramount importance of national agencies to work collaboratively with international agencies. Therefore, as depicted in Figure 1, the ideal scenario would be the international and national stakeholders carrying out the activities in the upstream such as hazard detection and monitoring collaboratively. If there is an impending disaster, early warnings should be passed to national and local actors to evacuate the at-risk communities within a given short period (Δt). Thus, the damage to at-risk communities can be minimized.

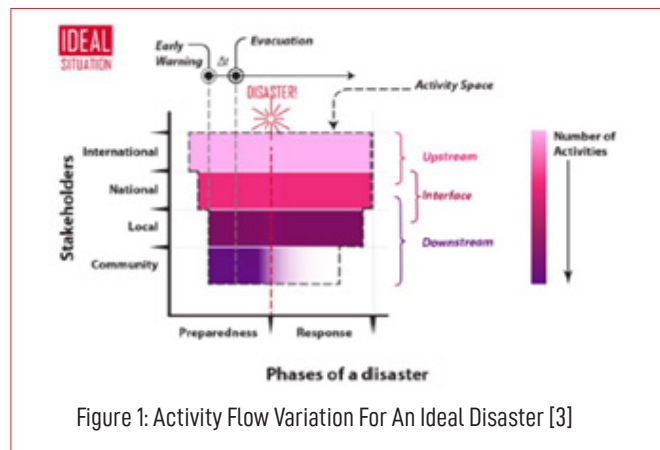


Figure 1: Activity Flow Variation For An Ideal Disaster [3]

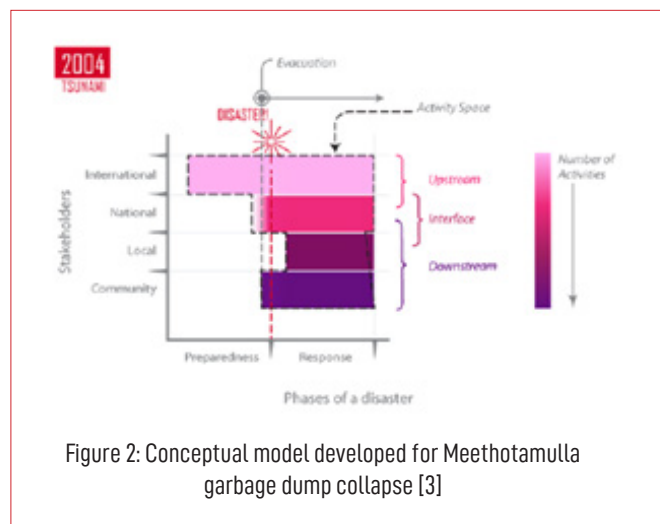


Figure 2: Conceptual model developed for Meethotamulla garbage dump collapse [3]

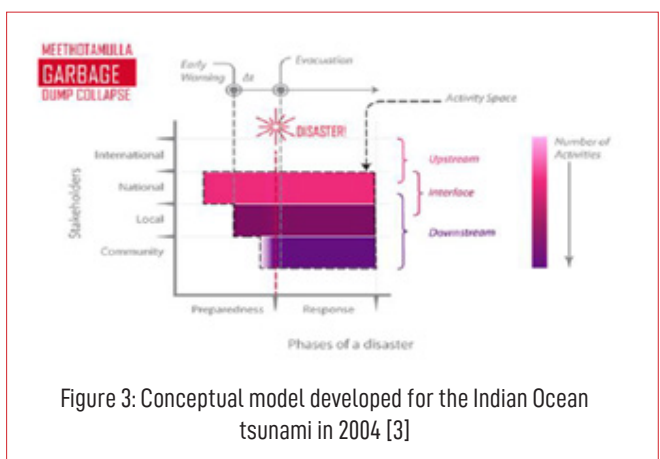


Figure 3: Conceptual model developed for the Indian Ocean tsunami in 2004 [3]

Capturing the Connectivity of Stakeholders in an MHEW system

In order to identify the behaviour of stakeholders in the MHEW environment, visualization of the communication network of stakeholders is paramount. Based on legally mandated emergency operation procedures in Sri Lanka. During a study conducted by the research team, the communication networks

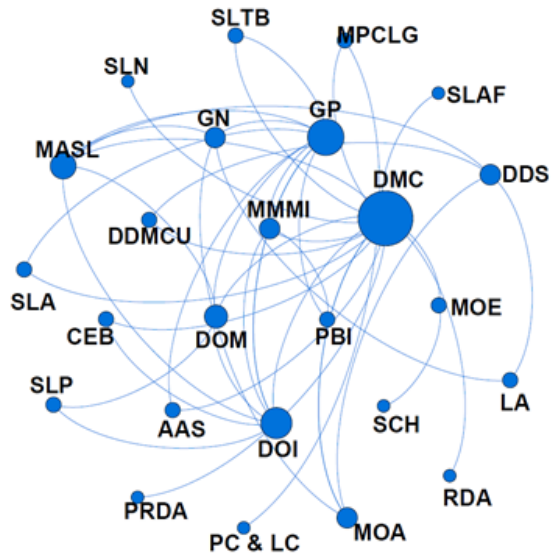


Figure 4: Stakeholder communication network for Floods [4]

of stakeholders were modelled for five frequently occurring and most severe hazards in Sri Lanka, floods, landslides, tsunami, cyclones, and droughts using Social Network Analysis (SNA) (see Figure 4). Stakeholders and their interrelationships were identified using the National Emergency Operation Procedures (NEOP) [4]. In Sri Lanka, Disaster Management Centre (DMC) acts as the key centralized stakeholder according to the centrality parameters used for the analysis. Therefore, DMC has a great significance in terms of receiving alerts from technical agencies and the dissemination of warnings.

Although DMC has been playing a leading role as a centralized stakeholder in most of the MHEW scenarios, a recent study conducted by the research team has revealed that the early warning system for biological hazards in the country is a health sector-led process [5]. Divisions functioning under the purview of the Ministry of Health are playing key roles in areas under the MHEW system. For instance, the epidemiology unit and quarantine unit are legally mandated as International Health Regulations focal points in the country while issuing early warnings pertaining to an impending outbreak. Furthermore, the Health Promotion Bureau [HPB] plays a key role in risk communication during health crises [6]

Tsunami Early Warnings and Evacuation Procedures

Tsunamis are one of the deadliest hazards that can occur at the moment. Among all types of hazards, Sri Lanka has the highest risk index for tsunamis (8.9 of 10), although the frequency of occurrence is comparatively [7]. Therefore, the effectiveness of early warning systems for tsunamis is paramount in mitigating its devastating impacts. Several studies were conducted by the Disaster Risk Management research team of the Department of Civil Engineering, University of Moratuwa, in collaboration with local and international institutions to investigate the efficacy of MHEW systems focusing on coastal hazards mainly. Use of technological platforms for early warnings, special needs of vulnerable communities in evacuation and shelter management, risk governance, and use of social media for disaster risk communication are a few areas that have been investigated by the research team [1], [8]–[11].

One of the research findings has emphasized the need for the stakeholder communication network



for rapid onset hazards like tsunamis has to be more simplified in order to avoid complexities. In this regard, a study that has utilized the SNA has modelled and compared communication networks using the relationships given in both National Emergency Operation Procedures (NEOP) and improved Standard Operation Procedures (SOPs) for tsunami response in Sri Lanka (see Figures 4 and 5) [4]. According to the comparison, the network developed through improved SOPs specifically denotes the relevant stakeholders in a much simpler way where the Early Warning information needs to be disseminated. Furthermore, it has identified the importance of including relief services such as NGO/INGOs and National Disaster Relief Service Centre within the network of stakeholders.

According to the survey findings of the research team, most communities in Sri Lanka believe that they are safe from disasters. Due to this overconfidence, they are reluctant to respond to early warnings. Furthermore, most people are attached to their personal belongings and do not comply with evacuation orders. Lack of trust in disaster man-

agement authorities is another reason for the public reluctance to respond [9]. Addressing the needs of marginalized and communities with special needs is another area that MHEW system needs to pay attention [12].

Although technological platforms for early warning dissemination have become a global trend, Sri Lankan communities are still relying heavily on traditional modes of communication such as Television and Radio to receive disaster risk information than modern methods such as social media. However, most of the communities

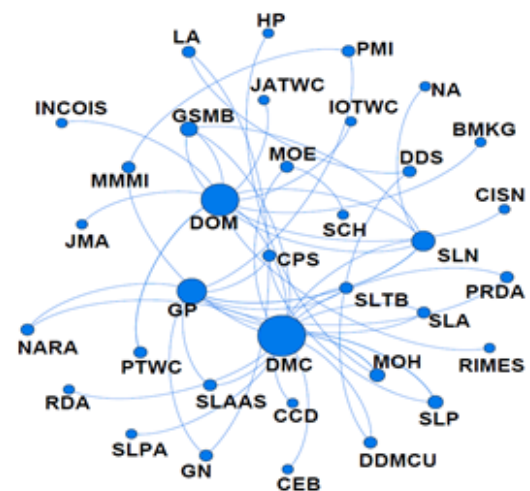


Figure 5: Communication Network for Tsunami Early Warning based on NEOP [4]

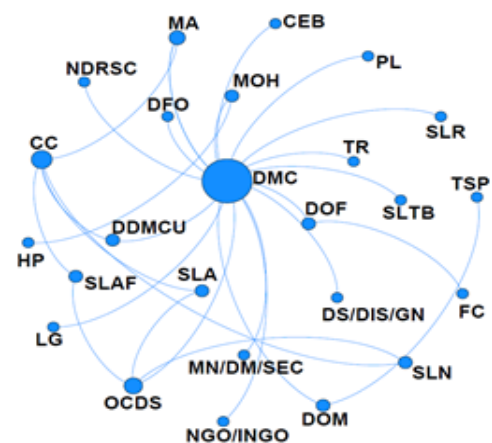


Figure 6: Communication Network Developed for Tsunami Based on Standard Operation Procedures [4]

believe that delivering early warnings as a text message would be more effective and useful for them. Although such systems are limited in the Sri Lankan context currently, SAYURU is a short message system that has become rapidly popular in the coastal region among fishing communities. This SMS based hazard alert warning system was initiated by the Department of Fisheries in collaboration with Dialog Axiata PLC.

An MHEW system is a complex system that includes various stakeholders and stages. Therefore, the complexity within an MHEW system is also high. Since the high complexity can reduce the effectiveness of the MHEW, more simplified technology enabled processes should be utilized in managing the system.

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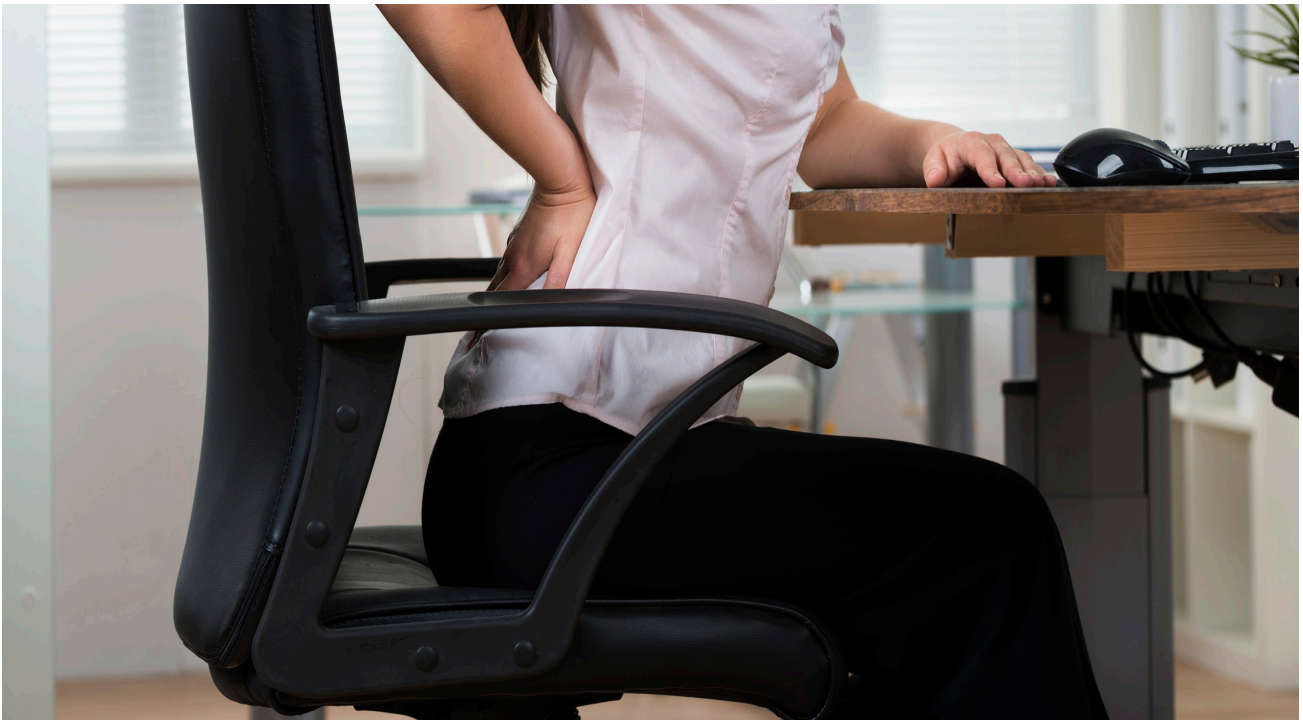
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Article by

Chandana Siriwardana, Ishani shehara, Gaidu Jayathilake, Ravindu Jayasekara,

Department of Civil Engineering, Faculty of Engineering, University of Moratuwa, Sri Lanka.

Have difficulty standing up? Soft exosuits are here to help!



Soft robotics is a novel disruptive technology that is revolutionizing the fields of robotics. Innovative use of compliant materials by researchers has elevated soft robotics over contemporary technologies. The Computational Sensing and Smart Machines (CSSM) laboratory of the Department of Mechanical Engineering, University of Moratuwa, has been taking strides in the development of soft robotics, ranging from actuators, sensors, and applications. The most recent output in this development is the first soft exoskeleton suit or "exosuit" in Sri Lanka. Researchers from CSSM have developed this exosuit as an orthotic device to aid in the sit-to-stand transition (StSt) of a person with lower limb impairments.

This exosuit focuses on helping a wearer from transitioning to standing posture from a seated position. The exosuit is worn as part of the wearer's pants and can actuate, assisting in parallel to their biological muscles while standing up from being seated. Aging, obesity, paresis, neuromuscular disorders, and trauma-induced lower limb muscle impairments can result in persons being restricted to a bed or a wheelchair. Being limited to such positions will make their lives sedentary, increasing the chances of secondary medical consequences and losing independence and quality

The research team from CSSM has used a novel, vacuum-driven soft artificial muscle actuator (LPVAc) that mimics biological muscle contraction to actuate the StSt assist exosuit.



Figure 1: Sit-to-stand transition assist exosuit

of life. This inspired the research team at CSSM to develop an exosuit that would improve their quality of life through leveraging novel soft robotic concepts.

Population aging results from declining fertility and increasing lifetimes, two trends associated with social and economic development. In the more developed global regions, older people increasingly live either alone or with only a spouse. In contrast, even the aging population would have to contribute financially to the younger generations in developing countries [1]. Sri Lanka's population is among the oldest in the non-developed world. Recent surveys find Sri Lanka as one of the fastest aging countries globally. They predict that Sri Lanka will have an elderly population above 60 years, reaching 30% by 2050 [2].

Another primary reason behind impaired lower limb functionality is paresis (weakened muscle performance) or paralysis (complete loss of motor function). A U.S. study reports that the primary reasons for paralysis were stroke (29%) and spinal cord injury (23%). Most spinal cord injuries were reported due to vehicular trauma. At the same time,

“ Persons in sedentary lifestyles need to be motivated and incentivized to try independent motion. Such attempts will help them regain their lost abilities the ”

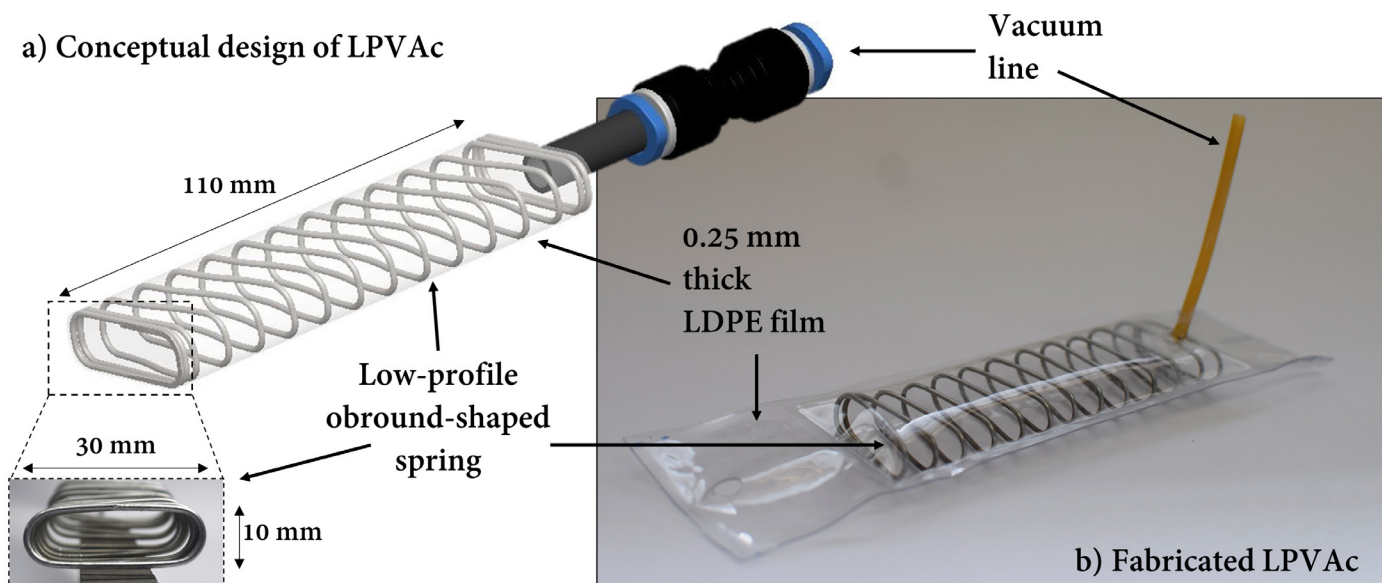


Figure 2: The novel vacuum-driven soft artificial muscle actuator: LPVAc. a) The conceptual design of the LPVAc. b) The fabricated LPVAc.

falls were the primary cause in the elderly population [3]. The most common non-traumatic injury leading to lower limb paralysis is the 'stroke.' In the Sri Lankan context, stroke is the second leading cause of death, with 15,200 recorded deaths in 2012. Stroke and subsequent paralysis were prevalent in about 77,000 persons nationally (2014) (0.37 % out of a total population of 20.77 million) and high as 10.4 per 1000 persons in Colombo [4], [5].

Hence, Sri Lanka faces a need to help those unfortunate to lose their muscle functionality due to the above reasons. Persons in sedentary lifestyles need to be motivated and incentivized to try independent motion. Such attempts will help them regain their lost abilities through rehabilitation or allow them to keep the current state without further deterioration. If they can be motivated to stand up effortlessly, it will promote other attempts at independent motions. This will reduce their reliance on passive-assistive devices (such as canes, walkers) and caregivers. People tend to be stigmatized when seen using such assistance. Hence, they would prefer any such assistive device to be invisible to the public. Therefore, the CSSM lab developed the StSt assist exosuit as an orthotic device that such persons can wear discretely.

The research team from CSSM has used a novel, vacuum-driven soft artificial muscle actuator (LPVAc) that mimics biological muscle contraction to actuate the StSt assist exosuit. This actuator is the first of its kind developed in Sri Lanka and is a lightweight (14 g), low-profile (30 mm x 10 mm) actuator that can lift 4 kg. This means the LPVAc can lift 285 times its' self-weight. The low-profile nature allows for unobtrusive integration to wearable devices. When these characteristics are combined, the LPVAc becomes an ideal actuator for use with wearable devices that need to supply power to aid the motion of human limbs while still being hidden to an observer. The research team integrated the LPVAc into a novel soft wearable exoskeleton suit. This exosuit focuses on augmenting the lifting power of the gluteus maximums muscles of the lower limb. StSt requires the extension of hip and knee joints. The main muscle groups used during these motions are the

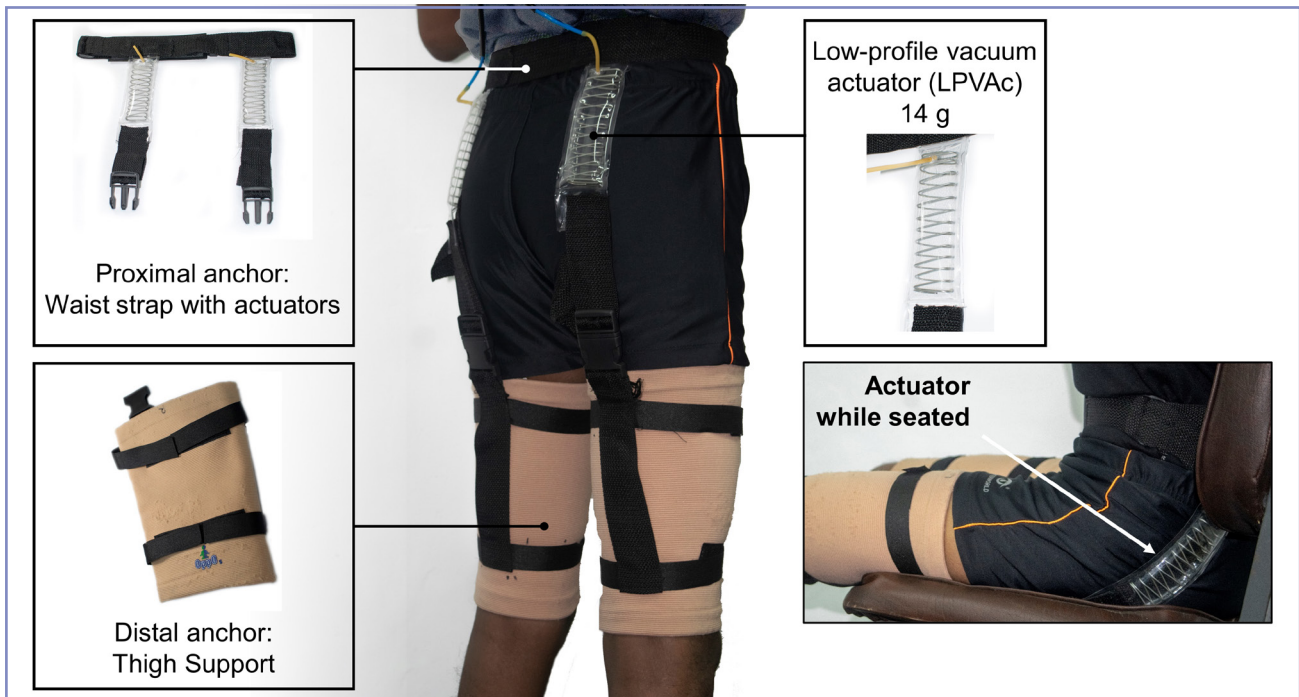


Figure 3: The main parts of the sit-to-stand transition assist exosuit. The inset shows how the LPVAc is unobtrusive during seated posture.

quadriceps femoris (QF) and the gluteus maximus (GM) muscles. The gluteus maximus is the largest muscle in the human body and does most of the heavy lifting of your body during motions against gravity, such as standing up or walking upstairs. Hence, the research team placed the LPVAc parallel to the gluteus maximus muscle to help it lift your body when standing up from a sitting posture.

The exosuit developed by the CSSM team is classified as a mono-articular exosuit as it augments only the singular gluteus maximus muscle in each leg. The research team designed the exosuit using lines on non-extension and anchor point concepts of Wehner [6]. The exosuit is made from soft inextensible webbing straps, which act as anchors and force guides. To make sure the donning and doffing of the suit is made easier for a user with impaired muscle strength, the exosuit is made in parts. The base part is worn around the hip and can be adjusted to the wearer's waist using push-on quick-release buckles. The distal portion is worn as two thigh support sleeves that tighten the suit at the wearer's thighs. The LPVAc is connected in between these two parts using push-on quick-release buckles. The exosuit uses one LPVAc per leg. The complete exosuit weighs only 324 g, and

“The exosuit developed by the CSSM team is classified as a mono-articular exosuit as it augments only the singular gluteus maximus muscle in each leg”

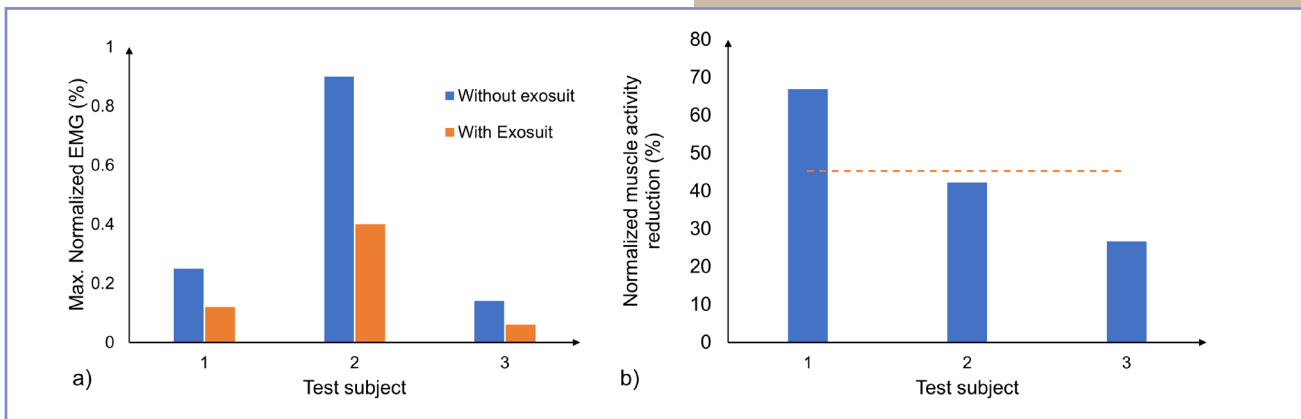


Figure 4: The performance validation of the exosuit. a) The observed normalized EMG readings from the gluteus maximus muscle activity in three test subjects without the exosuit and with the exosuit. b) The observed reduction of EMG activity as a percentage. The dashed line shows the average reduction of 45%.

most of this weight is anchored close to the waist. By positioning most of the weight around the hip anchor, the metabolic penalty of carrying weights distally from the joint is also reduced.

The research team used healthy volunteers to assess the amount of aid provided by the exosuit during StSt. They used electromyography (EMG) signals (EMG tells you how much muscle activity is present by measuring the electrical activity) from the surface of the buttocks to measure the gluteus maximus muscle activity. The results obtained by the research team showed the suit reduced the muscle activity requirement by up to 66%, with an average reduction of 45%.

The researchers of CSSM have presented a comprehensive description of the design, development, and assessment of the StSt assist exosuit in [7]. This exosuit is one of the recent developments presented by the researchers at the CSSM laboratory. Both undergraduate and postgraduate researchers working under the banner of CSSM have actively contributed to the development of many soft robotic actuators, sensors, and systems. These researchers continue to work on the development of novel, smart applications involving these soft robotic technologies.

The members of the CSSM research team continuously strive to provide innovative solutions to improve the quality of life of humans, as shown by the contributions of the exosuit development team.

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Article by

Asitha Kulasekera, Rancimal Arumathanthri,
Damith Chathuranga, Ruwan Gopura,
Thilina Lalitharathne

Department of Mechanical Engineering, Faculty of
Engineering, University of Moratuwa, Sri Lanka

Towards a Sustainable Agri-Food Supply Chain



The agri-food industry is one of the largest manufacturing sectors in many developed and developing countries. This industry requires large volumes of natural resources. This resource requirement has been a key barrier to increasing production proportionately to cater to the increasing global population. Therefore, the agri-food supply chain has gained global attention to find sustainable solutions to solve global food security concerns. Due to the complexities such as high perishability and climate change, food loss has become a major issue and it directly accounts towards food security concerns in the contextual world. We lose approximately one-third of the global food production from human consumption annually with an estimated monetary value of about USD 936 billion [1]. This is estimated without considering the indirect impact on the environment and the additional cost borne by the society to cover this loss.

Sustainable agriculture was a very popular phrase for a long time in Sri Lanka. The domestic agricultural policy was formulated in 2019 and still, it

is at the draft level. Therefore, the local agri-food supply chain is fragmented, and the actions of the value chain actors are isolated. As a result of that, the agricultural sector is facing several issues including post-harvest loss. When it comes to the Sri Lankan agri-food supply chain, we annually lose 270,000 metric tons of vegetables and fruits which has an estimated value of Rs. 20 billion. This is around 30-40% of the total agri-food production in the country [2]. The integration between the supply and the demand is a major pain point that leads to this issue. As an example, due to the lack of a national level cultivation plan to cater for the local demand, farmers cultivate their lands according to their product preferences without a scientific understanding of future demand. This results in over-production for certain crops and farmers end up with huge losses in the end.

Despite several issues, national agendas, and discussions, the conventional agri-food supply chain in Sri Lanka continued with little or no support from the private or government institutes. Farmers continuously used chemical fertilizers for the crops and consumers purchased the products and added that to their meals without much hassle. The sudden move taken in August 2021 by the government, to become the world's first completely organic farming nation is challenged by many domain experts. As per the experts' opinion, this should be established with a bottom-up approach based on traditional farming knowledge, experience, and adaptability with the ecological environment of the farmers. However, still many farmers have not even started the transition process from conventional farming to organic farming and agricultural economists question whether it is a wise move to aim for an overnight shift in policy given the current economic crisis the country is facing due to the mismanagement, corruption of all governments and respective responsible institutes [3]. In spite of this, few motivated farmers made the change with small scale operations by converting to organic farming way earlier than this policy intervention in terms of promoting sustainable agriculture. This was an isolated attempt and it had only a tiny impact towards promoting organic agriculture at the national level. The main issues they faced is sourcing organic fertilisers at the right



Figure 1: LEAF Integrated Farm Management (IFM) Model

“ still many farmers have not even started the transition process from conventional farming to organic farming and agricultural economists question whether it is a wise move to aim for an overnight shift in policy given the current economic crisis the country is facing ”

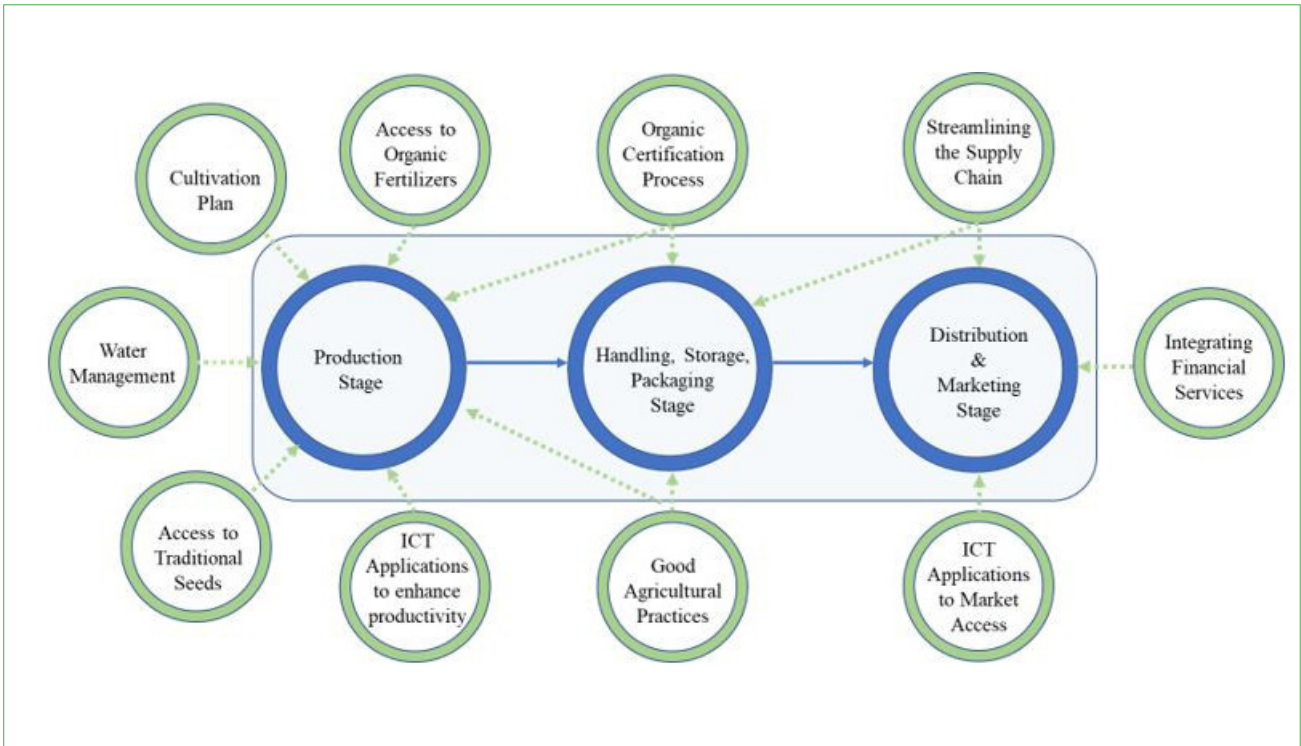


Figure 2: Summary

amount at the right time, water management, and the absence of a national level program [2].

Developing Trincomalee District as a “Sustainable Green District” was a programme initiated by the previous government and it focused on developing inland tank systems to harvest the rainwater and used it for the agriculture and inland fisheries industry. This programme managed to support more than 30,000 farmers to switch to organic cultivation. This was a successful sustainable solution for the issue of water management. However, there is a question on how to manufacture the required amount of organic fertilisers. Compared to conventional agriculture, organic agriculture requires larger volumes of organic fertilizers to be used for an acre. Therefore, sourcing raw materials such as paddy husks, cow dung and sawdust to produce enough organic fertilizers may be difficult, time consuming and expensive. Therefore, developing suitable fertilizer at an affordable price that can be commercialized must be a major concern in promoting sustainable agri-foods in Sri Lanka. Having said this, one of the most significant parts of this thrust is forgotten. That is the need to develop an integrated logistics platform that increases the

accessibility to organic fertilizer to any consumer across the island.

When considering organic farming, seeds used for the cultivation should be traditional varieties of the crop. Genetically improved versions are more responsive to chemical fertilizers rather than organic fertilizers. Therefore, in the cultivation process use of seeds of the traditional varieties will bring more yield than using genetically improved seeds with organic fertilizers [4]. In the current context, it will be difficult to source enough traditional vegetable and fruit seeds due to the popularity of genetically improved seeds with the Green Revolution creating a mismatch between policy and pragmatism. Hence, there should be a strategy to source and distribute an adequate quantity of seeds for the farmers isolated in different regions of the country. During the cultivation period and harvesting period adopting Good Agricultural Practices (GAP) is essential and the use of Integrated Farm Management Models (IFM) will be useful in the decision-making process which will help to enrich the community and the environment [5]. Adding to that, the use of ICT driven applications to get weather updates, advisory services to improve

the yield will be more supportive for the farmers in the production stage. Applying Industry 4.0 technologies such as Internet of Things (IoT) would go a long way in supporting these initiatives as well. Even after that in the handling, processing, packaging, storage, distribution and marketing, there should be a nationally implemented program to ensure the practices followed in each stage [6]. The organic certification process can be the best benchmark to evaluate this and give credibility to the product. Additionally, logistics activities such as transport, inventory management and value adding processes should be optimized and streamlined to ensure the smooth product flow through the supply chain. In that way, the farmer will receive a guaranteed fair price while the consumer is having a quality product at a reasonable price. Introducing ICT platforms for market access is a much needed solution whether the country is adapting to organic farming or not. This would allow product prices to be transparent to the consumers and leverage is offered to the producer of the value chain to negotiation as well. Integrating these platforms with financial services such as online payments, credit-based transactions, and streamlining loan facilities through banks will be major advantages for all the value chain actors in the agri-food supply chain. Helaviru Digital Economic Center is a local example of a digital marketplace that facilitates trade activities for vegetable and fruit products. The Department of Transport & Logistics Management, University of Moratuwa too has local access to an internationally proven non-profit platform that can be rolled out with the necessary support from industry actors.

Continuous effort and scientific research should be extended to develop a sustainable agri-food supply chain and it cannot be changed by a simple policy alteration. There should be an integration between value chain actors across the entire value chain and solutions should be derived concerning their effect on the entire value chain instead of assessing the effect on that isolated stage. The value chain actors should buy in the solutions. In conclusion, when developing a sustainable agri-food supply chain it should be developed with proper planning at the national level considering the local and export market, understanding the complex na-

ture of the system with the integration of proper technological platforms.

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Article by

Madhava Jayalath, Amila Thibbotuwawa, Niles Perera
Department of Transport and Logistics Management,
Faculty of Engineering, University of Moratuwa, Sri Lanka

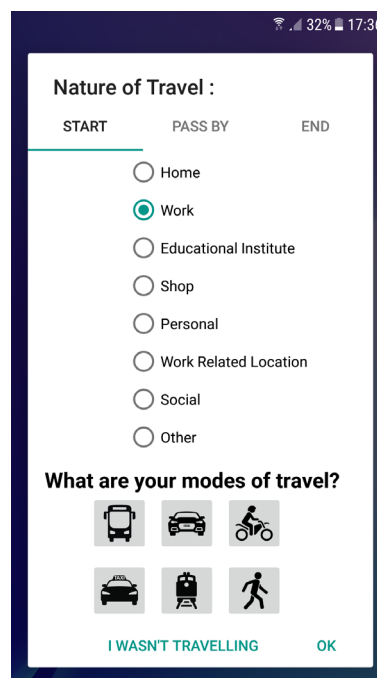
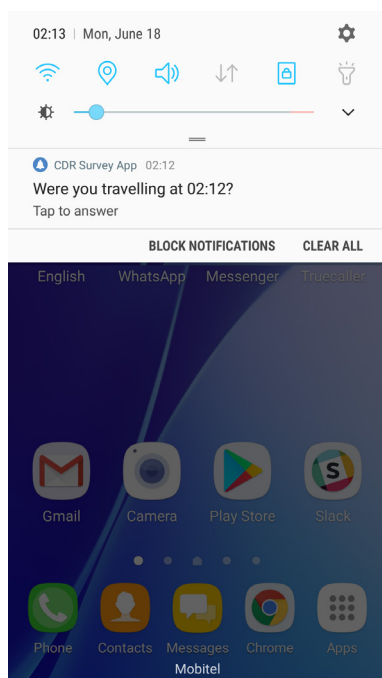
INTRODUCING A SMART PHONE-BASED TRAVEL SURVEY APPLICATION

Travel demand models, which are simplified representations of the real-world trip decision making processes, involve a series of steps that attempt to simulate complex human behaviour [1]. The travel simulation process starts by identifying the nature and location of a trip generating, captures its movement through a network of links and nodes up to the location of the trip attractor or destination [2]. The growing number of smartphone users assists in accumulating an enormous amount of individual location tracking data, which is customarily helpful for travel demand modelling. The introduction of a mobile application-based application for data collection supports in minimizing the embedded drawbacks associated with traditional data collection (Household surveys/ Roadside interviews) like higher cost, lesser frequency of conduct and most importantly, in household surveys, the accuracy of the study depends on the memory of the participant. This article aims to discuss a smartphone-based location tracking application to gather details of trip attributes made by mobile phone users such that the traditional data collection methods can be replicated.

A mobile application running on android and iPhone platforms had been developed to monitor user behaviour through cell phone localization and activity. The app is available for Android versions above API level 17, where the performance is above 94%. The app will consume only 3MB for the installation and 15 MB per month during the app's running. Considering the battery consumption, only

1% of the battery will be used by the app when the mobile device is fully charged.

CDR and GPS data are voluntarily collected in a pseudonymized manner from an unbiased sample of mobile users. The application runs in the background of the phone and collects data without user intervention based on the consent given in the initial installation. This non-intrusiveness aims to reduce the app's impact on participants within their daily routine. Users can download the mobile app from the Google play store. After installing the app, users can open the app and select the preferred language where the future functioning of the app will be based. Next, the registration window will appear so that users are required to fill up the general questions. Income is marked as an optional question, as it is a highly confidential matter. After that, a notification will popup (figure 1) if the user-initiated a travel by indicating the time. Since



the GPS mechanism identifies the travel initiation, there can be instances where notifications will pop up even without an actual moment. This is due to the GPS error in specific locations. The user can provide the answer by swiping the notification. If the user were not travelling, he would select the "I wasn't" button in the window. If the user is travelling, he can fill up the other questions on origin, destination, pass by destinations and the mode of travel. Users are allowed to select multiple pass by destinations and modes of travel, as shown in figure 2.

Since GPS locations will be collected from every user with a frequency of 10 minutes, it is mandatory to switch on GPS for the proper functioning of the app. If the GPS mode is not activated in a user, initially, a notification will pop up after 10 min of app installation to activate GPS. If the GPS mode is still inactive, the notifications will be sent repeatedly at previously defined times.

Replicating manual travel surveys with a smart-phone-based mobile app is the primary objective discussed above, and GPS data collection supports that with accurate location and time stamp recognition. The manual data filling of the users provides the other trip attributes. Therefore it can be concluded that this travel survey app design and implementation provide a realistic, helpful

vision into the development of similar platforms and approaches for travel and activity surveys. The main drawback is the reluctance of the users to participate in the survey. The study's success is based upon the level of user involvement during the process, which is required to be motivated by awarding data or any other monetary incentive. One additional proposed benefit for the users is displaying a travel summary at the end of the day so that users can review their own travel activities.

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Article by
Bhagya Jeeewanthi¹, Amal Kumarage¹, Ayesha Rathnayaka²,
Amal Shehan Perera²

¹Department of Transport and Logistics Management,
Faculty of Engineering, University of Moratuwa

²Department of Computer Science and Engineering,
Faculty of Engineering, University of Moratuwa



A World of Waste in One Cubic Meter – Portraying Waste to Life



Figure 1: Aerial View of Karadiyana solid waste site – University of Moratuwa is in the background

Rapid economic growth, urbanization, and increasing population have caused resource consumption to increase, and the consequent release of large amounts of waste to the environment. By 2050, the amount of waste generated in developing countries will see a threefold increase. The Asia and Pacific region will generate most of the world's waste- a considerable 23%. In developing nations, recyclables as plastic and paper, metal, and glass make up a substantial fraction of waste streams, ranging from 16% in developing countries [1]. We need to bring in circularity to avoid an environmental catastrophe and assessing circularity is the first step in this right direction. The study focuses on the composition of waste in a one cubic meter and identify the potential of

resource circularity while justifying the economic value of the waste. Understanding the economic value of waste would lead to a better understanding of opportunities that lie hidden. With this goal, the Karadiyana site, which is adjacent to University of Moratuwa was studied from an urban waste generation perspective. Waste generated in the Biyagama Industrial Zone was also studied from a mixed industrial waste perspective. The valuation of garbage mounds and practices in these two places was an objective. When value is realized the circularity is increased.

Methodology

Methodology derives from the Biocube concept of evaluation of bio-diversity. The interest in emulating the Biocube program was inspired by a



Figure 2: Karadiyana Waste site



Figure 3: Mixed waste at Biyagama Industrial Zone



Figure 4 : Sample analysis at Karadiyana and Biyagama EPZ

feature article in the National Geographic [2]. The cubes were from around the world and highlighted several things about biodiversity in small spaces, including a staggering number of nook and cranny species. Almost every cubic foot sampled yielded hundreds of species.

The concept was developed to analyze the material categories in a typical Municipal Solid waste site and the waste generated in industrial sector. The cube here would yield potential 'cradle' value. The sample volume size is selected as one cubic meter as it can directly link with the sample density in the experiment. The experiment is conducted for fresh non-biodegradable waste coming into the waste site and waste generated in industrial zone. The main environmental burden is evident, as these waste categories mainly comprise of (waste of paper, cardboard, plastic, metal, rubber, leather, glass, clothes, e-waste & offensive waste). Results are identified by segregation and weighing the categorically segregated waste samples. Garbology is a fascinating subject of looking at waste in deciphering behaviour and potential.

Analysis

A specially designed One cubic meter frame is used for sample collection. Ten test samples were analyzed out of 65 waste trucks that are carrying fresh waste from the household to the waste site. In the industrial waste analysis, 10 random samples were analyzed from mixed waste received from textile and apparel sector industries in the zone.

Results and discussion

Main waste categories in the Karadiyana waste site were identified as Paper and cardboard 28.4%, Mixed plastic 28.36%, Clothes 7.73%, Mixed waste 11.08% as major waste streams above 3kg on a weight basis in one cubic meter volume. The average specific density of the test cube was 49kg/m³.

Paper(29%), cardboard(28%), plastic (15%), polythene (8%) and fabric (4%) were the main waste categories identified in the Biyagama Industrial Processing Zone. The average specific density of the test cube was 30.8 kg/m³.

Economic value of one cubic meter of waste

Karadiyana waste site (waste of household)

Following the visual inspection of the 49kg of waste in one cubic meter volume, it was identified that 42.64kg of waste can be diverted to material or energy recovery with direct waste material value



Figure 5 : Waste inspection visit at Karadiyana waste site



Figure 6 : Waste analysis at Karadiyana

of approximately 1299 LKR (recyclate valued at October 2021 rates). However, waste management expenditure such as segregation, transportation yard management etc, and the environmental impact of mismanagement of waste were not considered .

Biyagama Industrial zone

The Economic value of one cubic meter volume of industrial waste was approximately 1622 LKR. The Cube also enabled industry to identify the potential almost immediately.

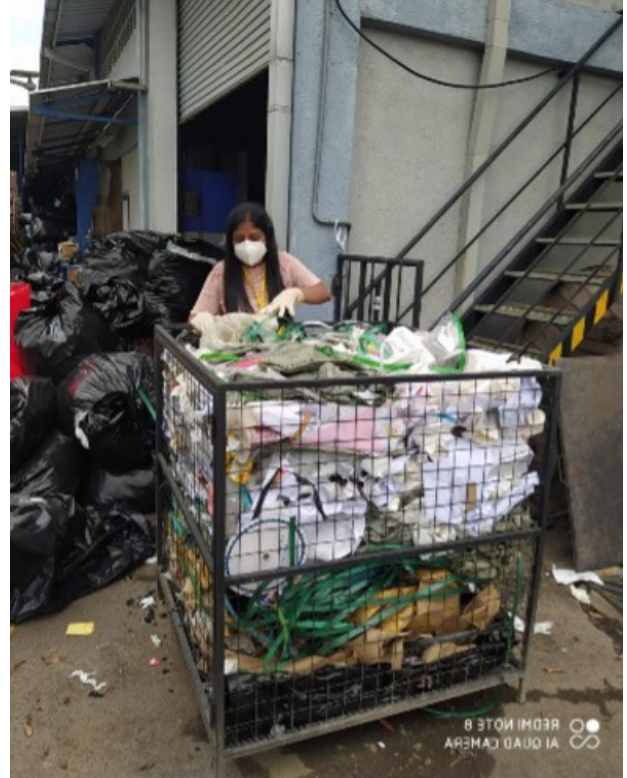


Figure 7: Waste analysis at Biyagama EPZ

A surprising observation was the closeness of municipal solid waste to the industrial waste value assessment. This is however a comparison that has not been done before for the same time period.

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Article by

Lakmini Edirisnghe ¹, Arosha Hemali ¹, Ajith de Alwis ¹
Mayuri Wijesundara ²

¹Department of Chemical and Process Engineering, Faculty of Engineering, University of Moratuwa, Sri Lanka.

²Engineering Management, Deakin University, Australia

The Impact of Incentives and Regulatory Regimes on Changing Customer Behavior

A Study based on the Power Utility Customer Segments in Sri Lanka

This study aims to develop a scientific model to ascertain the impact of incentives, regulatory regimes, and new technology products on the behavior of different customer segments of the electricity market, in order to conserve energy and address the current problem of peak power deficit in Sri Lankan electricity sector.

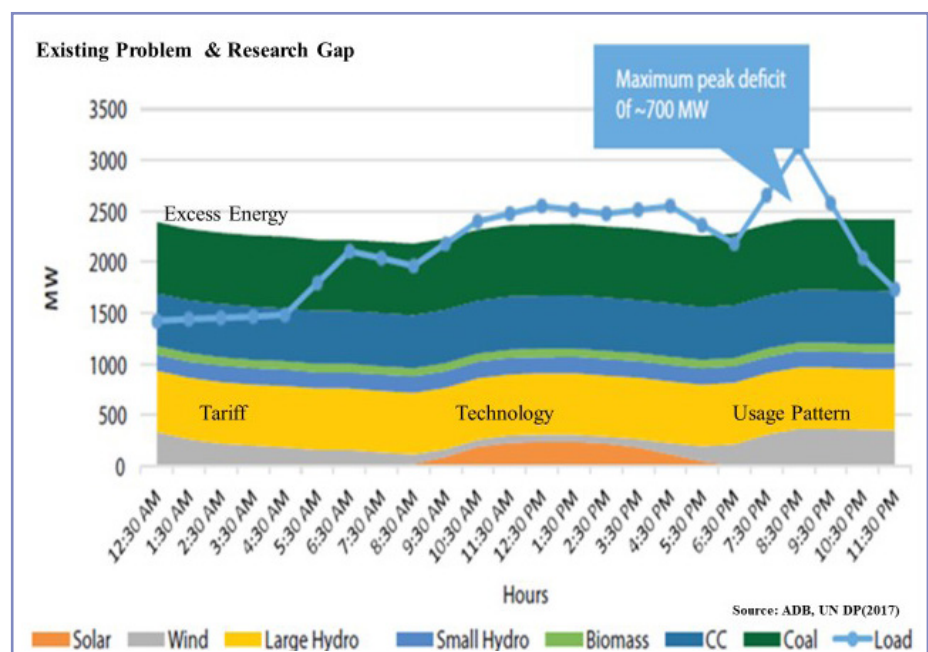


Figure 1:
The current problem of peak power deficit in the Sri Lankan electricity sector

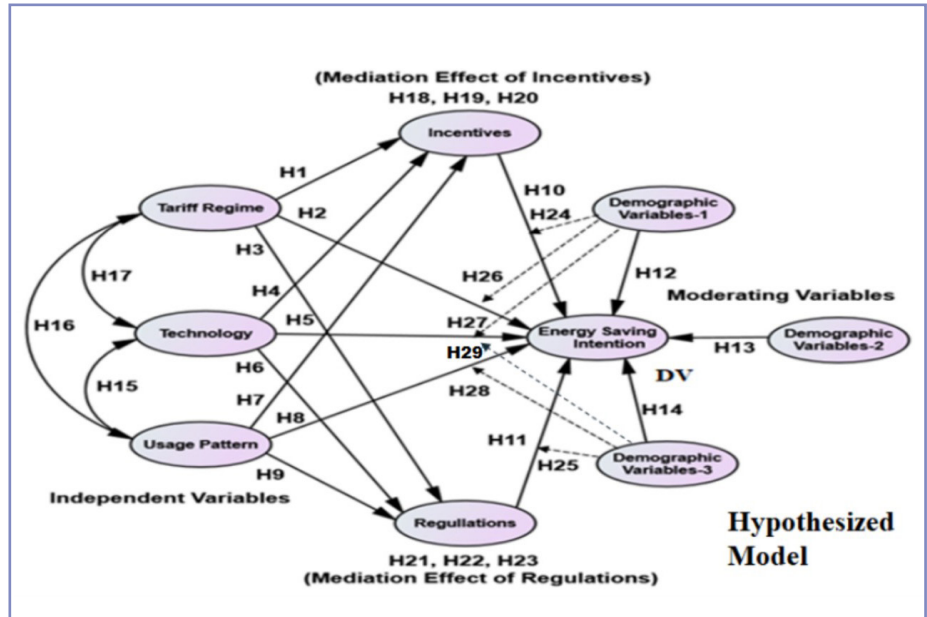


Figure 2: Hypothesized Model

Integrating tariff regimes and technological improvements with human behavior make three independent constructs on which the entire research builds. Customer perception on different interventions to conserve electricity based on these constructs measures using cross-sectional questionnaire survey as the research philosophy which preserves positivistic deductive approach. It assures the answer to existing organizational issues and hence becomes action research with blended mixed-method. The integrated model was evaluated, reduced, and re-specified using the Structural Equation Modeling (SEM) technique. The data analysis technique further uses AMOS and SMART PLS - 3 software during testing of mediation and moderation effects of different interventions as a matter of triangulation of results. The study examined three customer categories, mainly industrial, commercial, and domestic sectors, with 1500 samples to form the empirical

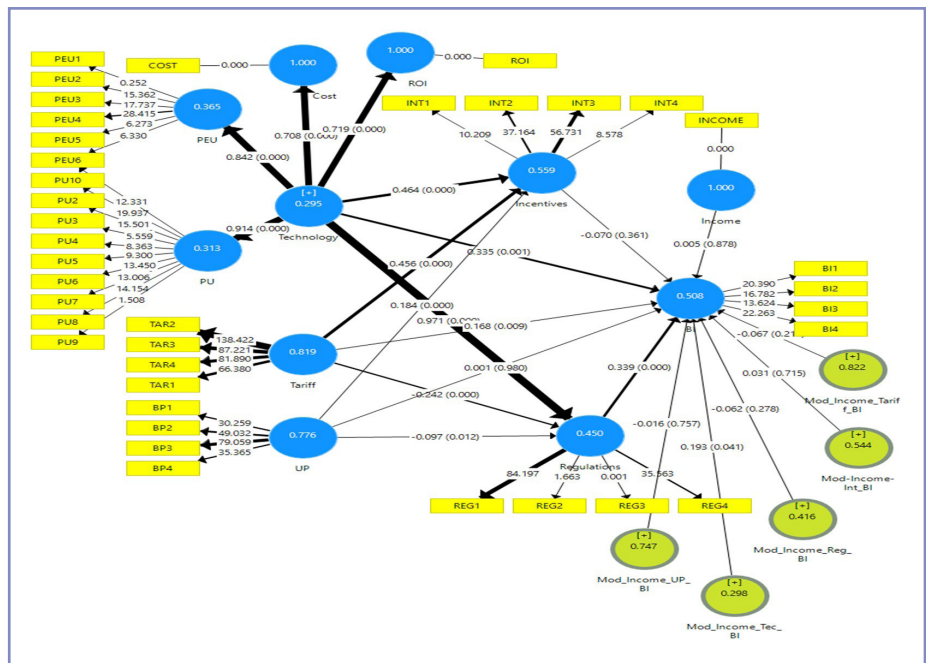


Figure 3: Domestic Consumer Model

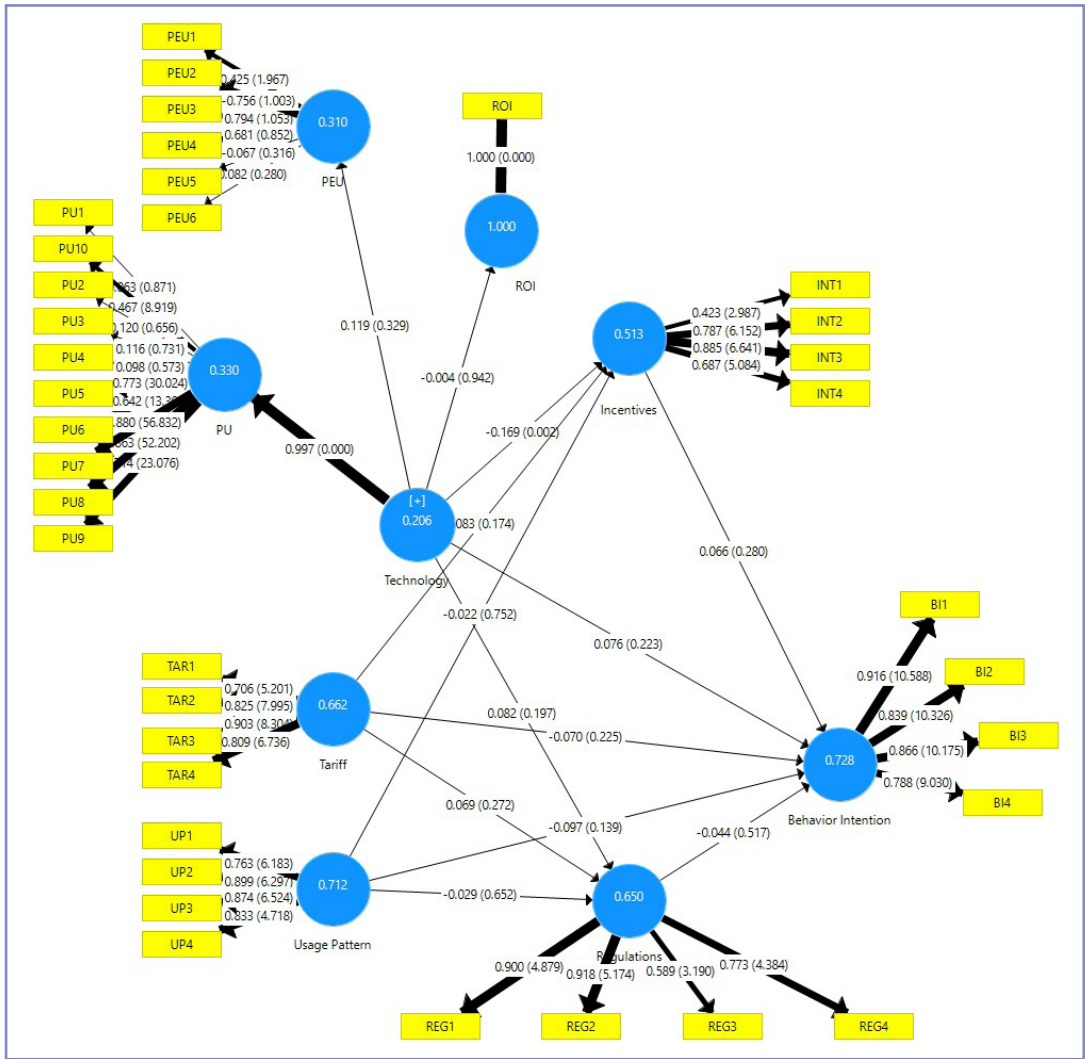


Figure 4: Commercial Customer Model

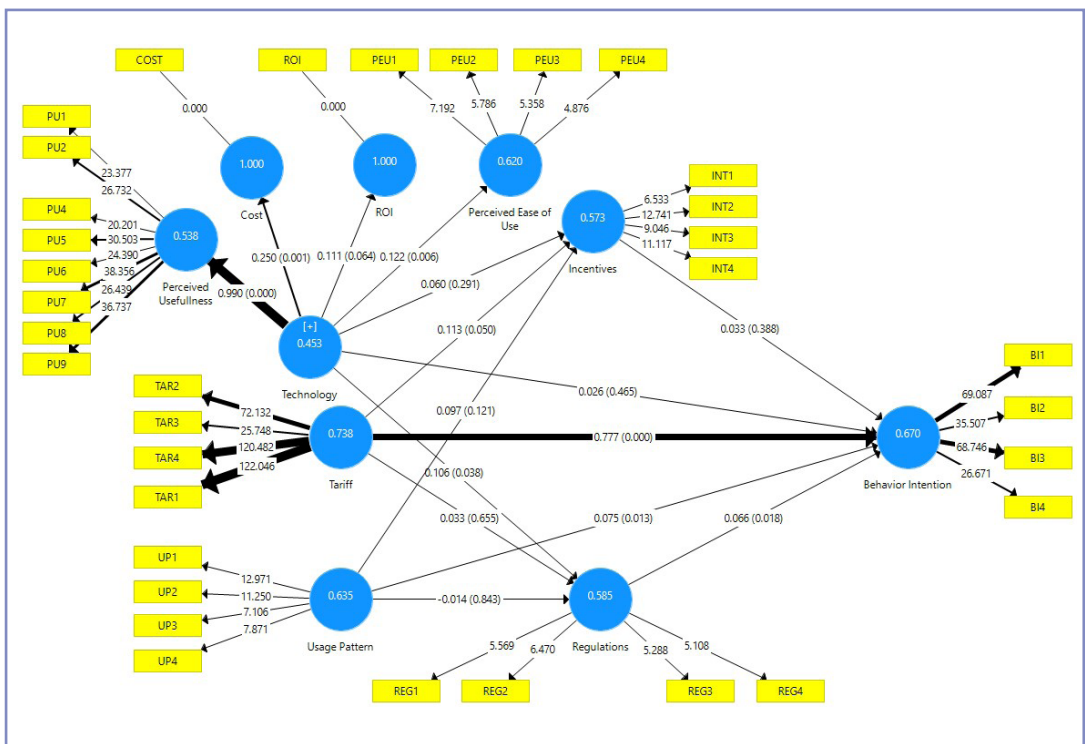


Figure 5: Industrial Customer Model

“This research study explored three tariff sectors in the Sri Lankan Electricity industry rigorously. It blends the determinants of energy conservation to form a new scientific model that can explain an individual component behavior separately and collectively”

data. The finalized model was then validated using face-to-face interviews with 100 randomly selected customers among all three groups.

Findings of the Study

This study identified significant relationships between research variables and formulated the required policy directives on possible intervention mechanisms for sustainable energy conservation in Sri Lanka. The findings show that existing incentive mechanisms focusing on lower-end domestic customers are ineffective. There exists no significant mediation for industrial customers whilst commercial customers can partially be mediated by incentives and regulations. Domestic customers can further be mediated by regulations on the proper use of tariffs and energy conservation technologies. It is further found that the income and the education level of domestic customers impact the relationship between the use of efficient tech-

nologies and changing behavioral patterns related to energy conservation. The use of the 6P concept on moderating the relationship between technology and changing usage patterns of commercial customers is also proven statistically. The model converged can be used as a scientific instrument to explain the future actions needed for sustainable energy conservation in the Sri Lankan Electricity sector.

Practical implications of the study

This research study explored three tariff sectors in the Sri Lankan Electricity industry rigorously. It blends the determinants of energy conservation to form a new scientific model that can explain an individual component behavior separately and collectively. Furthermore, integrating the existing three accepted models to form a single instrument is an outstanding achievement. In addition to that, formulating a scientific model which can explain human behavior in the light of different interventions provides a practical solution to an existing problem in this large organization, which is fully responsible for the whole country's electricity generation, transmission, and distribution aspects.

Article by

[Witharamage Jayaratne](#), [Sarath Dasanayaka](#), [Darshana Mudalige](#)
Department Management of Technology and Industrial
Management, Faculty of Business, University of Moratuwa, Sri Lanka

Decolourization of textile dyes and textile industry effluent in a fixed bed biofilm reactor using native microorganisms

Textile and apparel industry plays a huge role in the Sri Lankan industrial sector, accounting more than 40% of export earnings in the country. Textile wet processing produces large volumes of coloured effluents which have potential to cause negative impacts on environment and various adverse health effects if not properly treated [1]. Chemical and physical effluent decolourization techniques which are widely used in industry have major drawbacks such as high cost and generation of secondary sludge which require further treatments [2]. Therefore, textile dyeing industries face huge problems in achieving sustainability goals, due to this coloured textile effluents. In the recent past, biological treatment methods have captured attention as environmentally friendly and cost-effective techniques to remove colour from textile effluents.

This study focused on isolating native microorganisms with textile dye decolourization potential and investigated their applicability in textile wastewater decolourization. During the study, five bacterial strains with dye decolourization potential were isolated and identified using sequencing analysis of 16S rRNA gene. Bacterial consortium was developed by selecting the most effective isolates, and batch decolourization of individual dyes and dye mixtures were carried out in suspended cultures.

The study was further extended to investigate decolourization in a laboratory scale fixed bed biofilm reactor (FBBR) consisting of a developed bacterial consortium (Figure 1). A synthetic dye mixture (50 mg/l) was treated in the FBBR in batch mode with three different concentrations of yeast extract (YE) as the carbon source in the feed, and more than

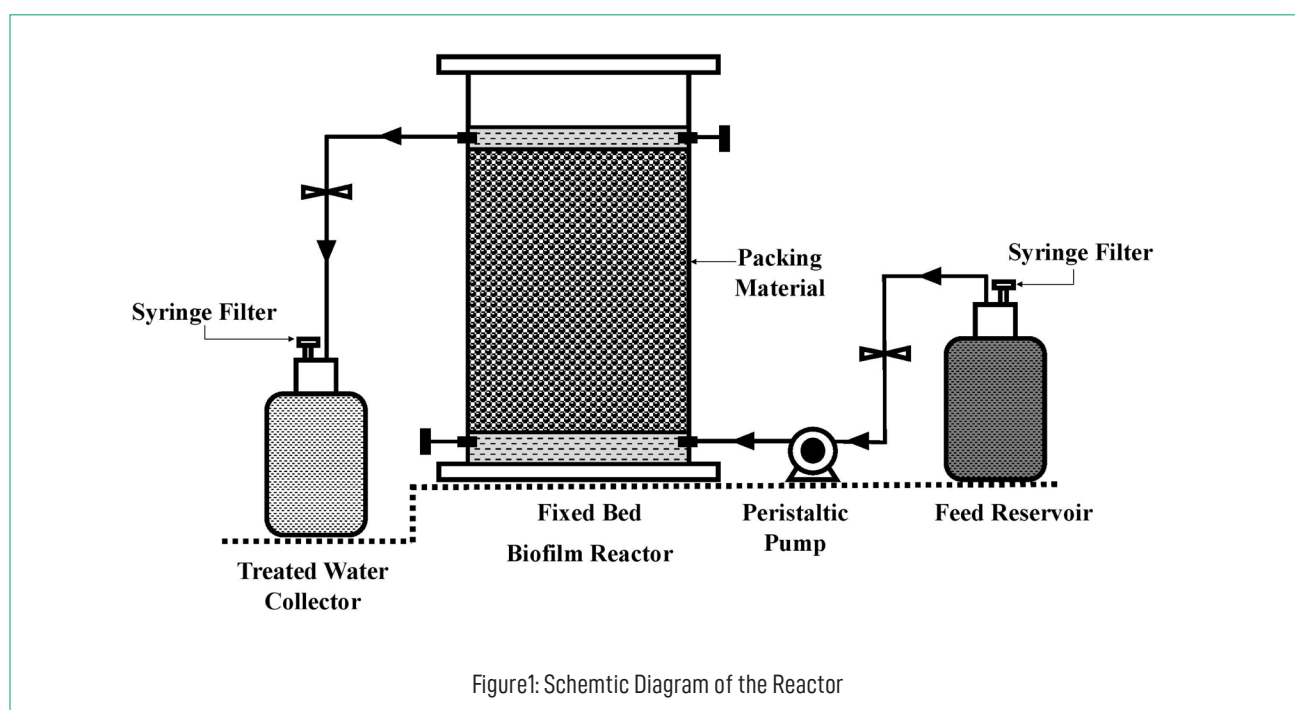




Figure 2: a). Influent (50ppm synthetic dye mixture containing medium), b). Treated water obtained from continuous FBBR

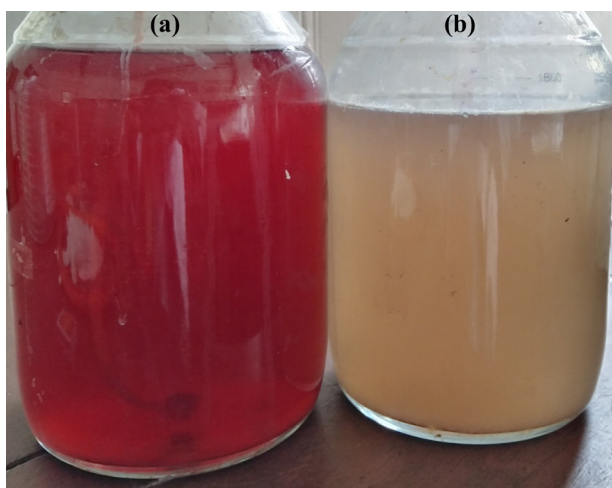


Figure 3: a). Feed (undiluted textile effluent containing medium), b). 48h treated water obtained from FBBR

90% decolourization was observed when the YE concentrations were 2 and 1 g/l.

When the same dye solution was treated in a continuous FBBR (1.9 d hydraulic retention time) up to 83% colour has been removed with 2 g/l YE. A considerable reduction in dye decolourization was not observed when the YE in the feed was reduced to 1 g/l and there was 85% mean decolourization of the synthetic dye mixture (50 mg/l) (Figure 2). When the concentration of YE in the feed was further reduced to 0.25 g/l, colour reduction was 75%, and the colour reduction achieved is very close to that in batch FBBR with the same dye and yeast extract concentrations. Furthermore, 70% of the

“ This study showed the ability of the developed bacterial consortium to endure in highly complex and toxic environment in the fixed bed biofilm reactor. ”

colour was removed in 48 h when textile industry wastewater was treated in batch operated FBBR (Figure 3).

Structural changes which occurred in dyes due to biological treatments were studied using ultraviolet-visible spectral and high-performance liquid chromatography analyses. Metabolites formed due to biological degradation were analyzed using gas chromatography-mass spectrophotometry and were found to be non-toxic and benign.

This study showed the ability of the developed bacterial consortium to endure in highly complex and toxic environment in the fixed bed biofilm reactor. Further, biological treatment can be considered as a highly promising alternative technique for the treatment of textile dye-containing wastewater in industry since treated water is nontoxic.

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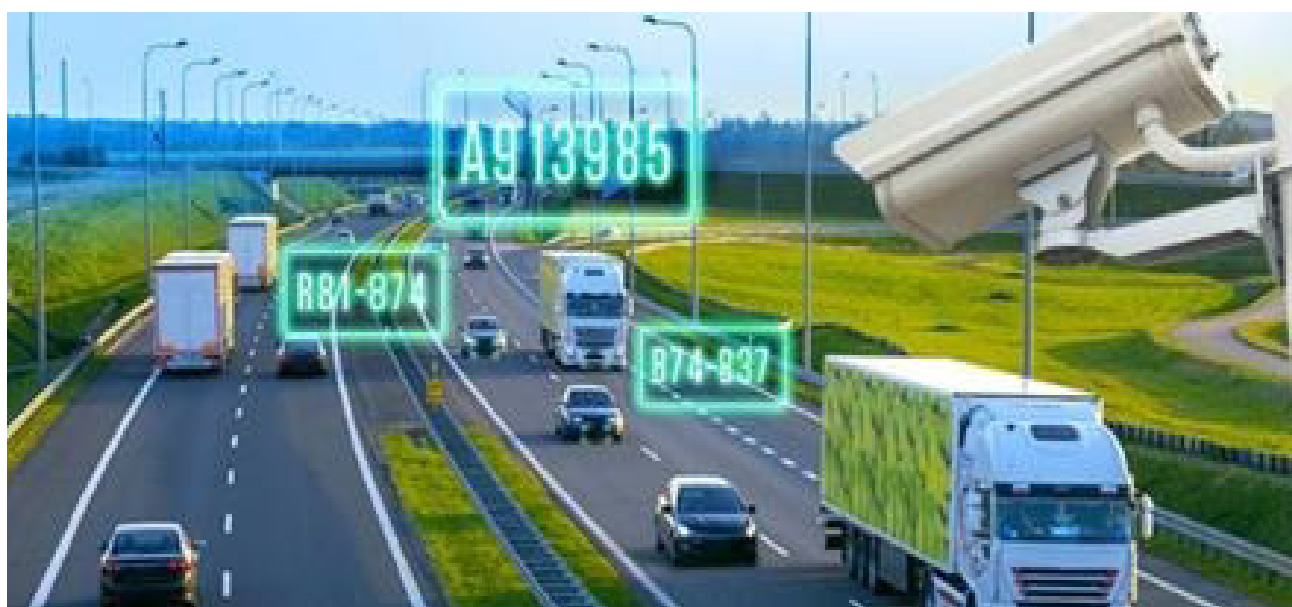
Article by

Gimhani Madhushika, Thilini Ariyadasa,
Sanja Gunawardena

Department of Chemical and Process Engineering,
Faculty of Engineering, University of Moratuwa, Sri Lanka

Automatic Vehicle Number Plate Recognition

Using Deep Learning Algorithms to Estimate the Vehicle Storage



Identification and tracking of vehicles are essential for control and surveillance of transport systems. It is important not only for traffic control but also to estimate vehicle storage within a cordon of city. This is vital process in deciding to provide or restrict parking and other relevant facilities based on vehicle storage within a city in a given period of time. This can be identified by tracing vehicle-in and vehicle-out time of city cordon. The most effective method is to track vehicles using vehicle Number Plate (NP) as it is the unique notation for each vehicle.

The manual Number Plate Recognition (NPR), commonly used method, suffers from time and cost as well as errors. With the advancement in applications of artificial intelligent, NPR using image processing became popular.

There are many researches with different techniques. Edge statistics and the morphology [1] where vehicle number plates and details were captured using still images and videos, Modular systems [2] which is a deep neural network technique, Optical Character Recognition (OCR) techniques [3], combination of RFID and image recognition techniques [4] etc. However, in the recent past deep learning, branch of machine learning, Automatic Number Plate Recognition (ANPR) techniques came to practice. The most widely used technique is Convolutional Neural Network (CNN).

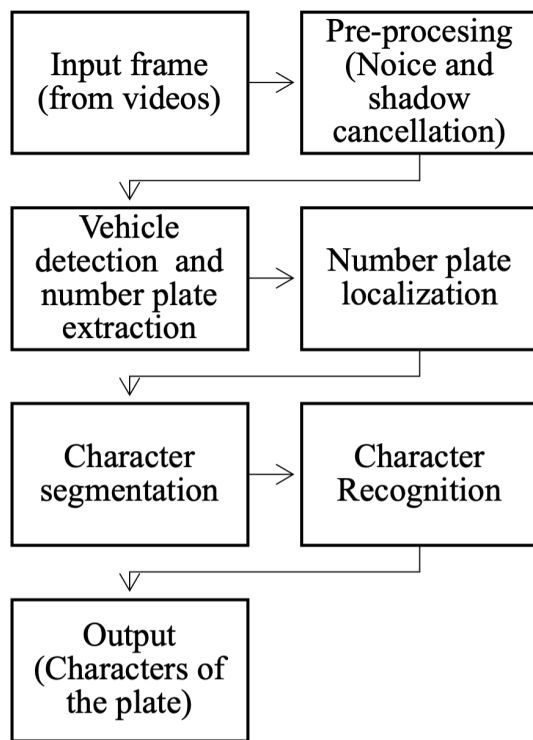


Figure: Basic structure of ANPR model

The objective of this research is to apply ANPR techniques to identify vehicle storage within a city in a given time. This research has two phases. Phase 1 is development of ANPR model by using CNN as it the latest and widely used method. This consist of 3 steps, namely, data collection, model development and model application for predictions. Collected data will be divided in two parts. One for training and model development and the other set of validation. Basic structure of ANPR model is given as above.

After the data is extracted from ANPR model to a database, estimation can be carried out. Data set will include vehicle number, date, time and also location of data collection too can be added.

Phase 2 is applying the model for estimating vehicle storage. After data cleaning, estimation of vehicle storage in a given area for a given period of time will be calculated using NP numbers within the city. Furthermore, this research can be used to estimate the time period a particular vehicle stayed within the city as well.

Therefore, significance of the research is Developing ANPR model using Deep Learning for vehicle storage estimations for a given city and provide evidence based supports for parking management, traffic management and other transport policy makers.

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Article by

Nathasha Manoli, Thillaiampalam Sivakumar
 Department of Transport and Logistics Management,
 Faculty of Engineering, University of Moratuwa, Sri Lanka

RESEARCH WEEK OVERVIEW

Inauguration	November, 30
Keynote Speech	November, 30
Postgraduate day	November, 30
Undergraduate Projects	December, 01, 02, 04
Global Research Forum	December, 02
Projects of Multidisciplinary Research Centres	December, 03
Research Conferences	
ICITR 2021	December, 01, 02, 03
ICBR 2021	December, 03
FARU 2021	December, 03, 04



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University of Moratuwa invites you to participate in Research Week 2021 multidisciplinary event comprised of a three international research conferences of the Faculty of Architecture, Faculty of Business and Faculty of Information Technology. This is to explore how excellent and relevant research is delivered at the University and beyond.

KEYNOTE SPEECH Prof. Mohan Munasinghe

- Chairman, Presidential Expert Commission (PEC) on Sustainable Sri Lanka 2030 Vision and Strategic Path
- Distinguished Guest Professor at Peking University, China
- Vice Chair of the UN Intergovernmental Panel on Climate Change (IPCC-AR4)
- Shared the 2007 Nobel Prize for Peace
- Received the 2021 Blue Planet Prize – The Environmental Nobel Prize



“Transdisciplinary Research to Address Climate Change and Sustainable Development Issues - Key Role of Universities”

GLOBAL RESEARCH FORUM THURSDAY, DECEMBER 02

14.00-18.00 IST

As one of the leading research and academic hubs of the country, University of Moratuwa is oriented to create people and economy centric R&D and Innovation echo system. Starting from the macroeconomic perspective and emphasising on the gravity of the problem, the Global Research Forum expects to create an effective dialogue around the below key areas of the country.

Fostering Effective Flow of Academic Knowledge and Research Results into the Industry and the Society in Facing Global Challenges

Bridging Academia and Industry: Towards Sustainable Development

R & D for Digital Economy

Policy Establishment Towards Sustainable Economic Growth

With the involvement of local and global industry and academia partnerships, the Global Research Forum expects to identify multidisciplinary research domains and possible experts to tackle these key areas.

POSTGRADUATE DAY TUESDAY, NOVEMBER 30

“Peer Review: How to Write and Respond”
11.00-12.00 IST

Dr. Tirthankar Ghosal
Charles University, Czech Republic

PhD Journey - Panel Discussion
13.00-14.30 IST

Prof. Daminda Alahakoon
La Trobe University, Australia
Dr Thanuja Sandanayake
University of Moratuwa, Sri Lanka
Ms. Thrisara Wickramasinghe
University of Moratuwa, Sri Lanka
Ms. Nusrath Maharroof
Glasgow Caledonian University, UK

Research Methodology
14.45-16.15 IST

Associate Prof. Thayaparan Gajendran
University of Newcastle, Australia
Dr. Ranga Rodrigo
University of Moratuwa, Sri Lanka

Developing High Impact Journal Publications
16.30-18.00 IST

Prof. Paul Chan
Delft University of Technology,
Netherlands

PROJECTS OF MULTIDISCIPLINARY RESEARCH CENTRES FRIDAY, DECEMBER 03

13.00-17.00 IST

National Language Processing Center

Data Science Engineering and Analytics Research Center

Center for Biomedical Innovations

UoM Urban Labs-Center for Cities

Center for Intelligent Transport System

Center for Disaster Risk Reduction

Center for Advanced Robotics

Qbits- CodeGen

UNDERGRADUATE PROJECTS

DECEMBER 01

Faculty of Information Technology
10.00-11.30 IST

-Department of Information Technology
-Department of Computational Mathematics
-Department of Interdisciplinary Studies

Faculty of Architecture - I
11.30-14.30 IST

-Department of Architecture
-Department of Building Economics

Faculty of Engineering - I
14.30-16.00 IST

-Department of Civil Engineering
-Department of Chemical & Process Engineering

DECEMBER 02

Faculty of Architecture - II
10.00-11.30 IST

-Department of Integrated Design
-Department of Town and Country Planning

Faculty of Engineering - II
13.00-16.00 IST

-Department of Electronic & Telecommunication Engineering
-Department of Materials Science and Engineering
-Department of Textile & Clothing Technology

DECEMBER 04

Faculty of Engineering - III
10.00-13.45 IST

-Department of Computer Science & Engineering
-Department of Mechanical Engineering
-Department of Electrical Engineering
-Department of Earth Resources Engineering
-Department of Transport & Logistics Management

RESEARCH CONFERENCES

6th International conference on Information Technology research (ICITR 2021)

“Digital Resilience Reinvention”
1st -3rd December



4th International Conference on Business research (ICBR 2021)

“Entrepreneurism with Covid-Thriving in Turbulent Times”
3rd December



14th International research Conference (FARU 2021)

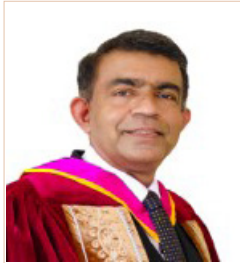
“Beyond Sustainability-Reflection”



Inaugural Lecture Series of the FGS, University of Moratuwa

Inaugural Lecture Series #01

Nature Based Landslide Mitigation, A Futuristic Approach

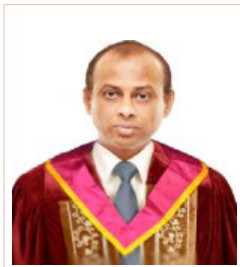


Prof. U.P. Nawagamuwa,
BSc Eng.Hons (Moratuwa),
MEng (AIT), DrEng (YNU), CEng, MIE(SL)
Department of Civil Engineerin,
University of Moratuwa



Inaugural Lecture Series #02

The Making and the Unmaking of National Physical Plan 2050



Prof. Jagath Munasinghe
BSc (Hons) (Built Environment), MSc (Architecture)
MSc (Town & Country Planning), PhD (NUS)
FSLIA, FITPSL
Chartered Architect and Town Planner
Department of Town and Country Planning,
University of Moratuwa



Inaugural Lecture Series #03

Restoration of Infrastructures: Fiber Reinforced Polymer Composites and Technology



Prof. J.C.P.H. Gamage
BSc. Eng.Hons.(Moratuwa),
MEngSc.(Monash), PhD.(Monash), CEng,MIE(SL)
Department of Civil Engineering,
University of Moratuwa



Inaugural Lecture Series #04

Is the Water Blue, Green or Colorless? - Revisiting my Career journey and Achievements in Water research



Prof. Lalith Rajapakse
BSc Eng.Hons (Moratuwa),
MSc (Saitama) , PhD (Saitama)
Department of Civil Engineering.
University of Moratuwa



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