ICSUSL 2021

Bridging Knowledge and Experience to Combat Global Challenges

PROCEEDINGS

of

8th International Conference of Sabaragamuwa University of Sri Lanka

and

2nd China-Sri Lanka Communication and Cooperation Forum

01st – 03rd December 2021

Belihuloya, Sri Lanka

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ICSUSL - 2021

"Bridging Knowledge and Experience to Combat Global Challenges"

8TH INTERNATIONAL CONFERENCE OF SABARAGAMUWA UNIVERSITY OF SRI LANKA

ICSUSL 2021

1ST - 3RD DECEMBER 2021

SABARAGAMUWA UNIVERSITY OF SRI LANKA, BELIHULOYA, SRI LANKA

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ICSUSL 2021 - "*Bridging Knowledge and Experience to Combat Global Challenges*"

As a continuation of the yearlong celebrations of the University's 25th Anniversary, the 8th International Conference of Sabaragamuwa University of Sri Lanka (ICSUSL 2021) is held from 1st to 3rd December 2021 at SUSL under the theme "*Bridging Knowledge and Experience to Combat Global Challenges*". A conference is not just an avenue for a scientist to present their research to the wider community, but an important venue for brainstorming, networking, and making vital connections that can lead to new initiatives. ICSUSL events have always been productive as they have provided opportunities to exchange and develop ideas, new strategies to approach research and get inspired.

Today, the global community is facing numerous challenges that they must necessarily overcome to sustain life. Bringing together multidisciplinary task forces equipped with required skills, knowledge, and lifelong learning through experience has become a critical requirement. This years' ICSUSL was planned around this requirement where we intend to bring together both researchers and practitioners who can successfully complement each other on to a common platform.

Despite the challenging times that we are experiencing, the University continues its cutting-edge discoveries of new knowledge through research. The conference comprises keynote and plenary speeches from eminent scholars, oral presentations, pre-conference workshops, and public discussions to provide ample opportunities for discussions and knowledge dissemination among researchers and scientists from different disciplines. Functioning as a virtual conference, ICSUSL 2021 will be unique and exciting for all participants.

We solicited abstracts under the seven sub-themes of ICSUSL 2021 that complement the main theme, and the response we received was simply overwhelming. After a thorough review by a panel of experts in the relevant disciplines, 150 abstracts were selected for publication as conference proceedings. In a nutshell, the conference will witness lively intellectual discussions and debates on several global challenges to arise in such fields as agriculture, sustainable development, and healthcare, and on how to apply geo-information science, applied sciences, technology, innovation, and creativity in tackling some global challenges, and also on envisioning the future of social sciences and humanities.

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Message from the Vice Chancellor

I am delighted to pen this message for ICSUSL-2021. I would like to take this opportunity to extend my warmest welcome for all the delegates and participants to Belihuloya, the host venue of ICSUL-2021, on behalf of the Sabaragamuwa University of Sri Lanka. ICSUSL-2021, the 8th edition of the biennial conference of the Sabaragamuwa University of Sri Lanka, is organized on the timely theme of '*Bridging Knowledge and Experience to Combat Global Challenges*', a proactive and transformative academic endeavor that aims at discussing the global challenges, the humanity will soon be confronting and at exploring feasible solutions to address them.

The outbreak of the Covid-19 pandemic, almost out of the blue, saw the world change radically, irrevocably in many ways. Even after a passage of two years and state-led vaccination programs worldwide, this deadly Coronavirus strain of the hitherto undetermined origin still has the world in its stranglehold. Worse still, it's mutating. However, thanks to the stringent public health measures and an island wide vaccination drive, Sri Lanka has brought it largely under control - largely, but not completely.

The economic setbacks caused by the Covid-19 pandemic will only serve to exacerbate the daunting enough challenges before the world. It is now or never and we believe this intellectual forum will ignite a seminal discussion, which will yield crucial ideas and insights for policy makers and legislators, both in Sri Lanka and elsewhere in the world, to help see the road ahead more clearly and prescribe policies and practices and mobilize the state machinery in the right direction.

We are honoured by the distinguished presence of Professor Lian Pin Koh, a Professor of Conservation Science, Technology and Policy in the Department of Biological Sciences at the National University of Singapore. Our Guest of Honour Mr. Dilhan C. Fernando, CEO of Dilmah Ceylon Tea Company PLC needs no introduction - his reputation as a major business personality in Sri Lanka does precede him. We are also deeply touched by the kindness and generosity of the Vice Chancellor of Huanggang Normal University, China for sponsoring ICSUSL-2021. I am positive the plenary speakers, being prominent academics and scientists all, have plenty to contribute to this momentous forum of ICSUSL-2021.

I unreservedly thank our Keynote Speaker, Guest of Honour, and Plenary Speakers for accepting our invitations to grace this occasion. I am also immeasurably grateful to the chair of

ICSUSL-2021 and the entire Organizing Committee for their untiring and innumerable efforts in organizing this amidst a plethora of formidable challenges and obstacles including some prolonged closures of the university. I wholeheartedly wish ICSUSL-2021 to become a resounding success in the truest sense of the word.

Prof RMUSK Rathnayake
Vice Chancellor
Sabaragamuwa University of Sri Lanka

Message from the Director, Center for Research and Knowledge Dissemination

As the Director, Center for Research and Knowledge Dissemination (CRKD), I take great pride in welcoming all the attendees to the 8th International Conference of Sabaragamuwa University of Sri Lanka (ICSUSL). In this remarkable year 2021, where the University is celebrating its 25th anniversary, CRKD has accomplished its vision by making a platform for multidisciplinary scientists to showcase their research findings, concepts and innovations through presentations and discussion under the theme of '*Bridging Knowledge and Experience to Combat Global Challenges*'.

In parallel with ICSUSL 2021, it is indeed a great pleasure to conduct the 2nd China-Sri Lanka Communication and Cooperation Forum in collaboration with Huanggang Normal University, China under the timely important theme '*New Challenges and Opportunities for China-Sri Lanka Exchanges and Cooperation in the Post-Epidemic Era*'.

We are more privileged to have Professor Lian Pin Koh, Department of Biological Sciences, National University of Singapore and Nominated Member of Parliament, Singapore as a keynote speaker and Mr Dilhan C. Fernando, Chief Executive Officer, Dilmah Ceylon Tea Company PLC as the Guest of Honour for ICSUSL 2021. We also look forward to listening to seven plenary talks given by both foreign and local eminent scientists.

This year, due to the COVID-19 preventive measures taken around, the organizers faced a new challenge in organizing a virtual session in parallel with the main event. I would like to thank all the members of the Organizing Committee, Dr. Enoka P. Kudavidanage (Chair), Dr. Rohan Abeywickrama and Dr. P.K. Sarath Munasinghe (Co-Chairs), Dr.K.P.N Jayasena and Dr..L. Sugeeswari Lekamge (Joint Secretaries), subcommittee chairs and members, Faculty Coordinators and Ms. SMF Shafnaz, Research Assistant, CRKD for their tremendous efforts to make this event a success.

More importantly, my sincere thanks are due to the authors of manuscripts, session keynote speakers, technical session chairs, rapporteurs, panel members, technical program committee members, reviewers, language editors and all other participants.

Prof MLM Chandrika Dissanayake
Director
Center for Research and Knowledge Dissemination (CRKD)

Message from the Conference Chair - ICSUSL2021

Greetings!

Welcome to the 8th International Conference of the Sabaragamuwa University of Sri Lanka. Humanity is facing major global challenges that are dynamic and transnational. These include hunger, climate change, environmental pollution, loss of biodiversity, and ecosystem services, as addressed by the United Nations' Sustainable Development Goals. Our capacity to survive through a crisis is on trial during this pandemic situation, resulting in socio-economic impediments. As a country, we are concerned about these challenges that are fuelled by inadequate public awareness of environmental issues, as they inevitably affect national development.

These complex issues require solutions through multi-sectoral approaches, partnerships, cross-border collaboration, and open innovation among governments, the private sector, local and international organizations, academia, other stakeholders, and creative, skilled, and experienced individuals. To scale up solutions with real impacts, it is necessary to translate knowledge into practical implications.

The theme of the 8th International Conference of the Sabaragamuwa University of Sri Lanka (ICSUSL) "bridging knowledge and experience to combat global challenges," identifies this requirement and the responsibility of the stakeholders and academia in this context.

A university is a knowledge hub that facilitates the growth of the nation's intellectual task force that can contribute to global development.

Successful dissemination of the knowledge generated in a university is a critical requirement in the process of combining it with the experience of practitioners and other stakeholders to generate applications. The dearth of knowledge reaching the ground-level application has often hindered science-driven decision-making in the country and our ability to reach global audiences.

With the provision of appropriate networking, both researchers and practitioners can successfully complement each other in the decision-making processes, thereby mitigating economic drawbacks and social implications of inadequate knowledge transfer.

The 8th ICSUSL was conceived with this issue in mind. The theme of the conference speaks of the importance of intertwining, respecting, and integrating knowledge and experience, where one component is truly not effective without the other. We offer a platform for scientists, students, professionals of government and non-governmental sectors, and grass-root level practitioners to interact. We highlight the value of combining advanced sciences with our traditional knowledge to meet tomorrow's requirements. Complemented by modern techniques, many of our traditional practices are well-suited for adapting to global challenges. We emphasize drawing from the individual strengths of stakeholders to achieve common goals.

The current COVID- 19 situation, unfortunately, has confined the conference to a virtual event, but we sincerely hope that this initiative will grow through the future activities of the university and future ICSUSL events. In the year of the 25th Anniversary of the University, we sincerely hope that the networking created through this conference will grow into a safety net that will help us make our tomorrow more secure.

Located in one of the most beautiful mountain valleys of Sri Lanka, rich in emerald forests, rolling spectacular terrains, bubbling streams, unique wildlife, minerals, other natural resources, and hospitable local communities proudly claiming a rich cultural heritage, the Sabaragamuwa University awaits your participation and the beginning of a long-lasting productive relationship to "bridge knowledge and experience".

Dr. Enoka P Kudavidanage
Conference Chair, ICSUSL-2021

Message from the Conference Co-Chairs

We are honored and pleased to welcome you for the 8th ICSUSL 2021 organized by the Sabaragamuwa University of Sri Lanka. The conference will allow us who are in the front line of this disastrous epidemic to re-orient, exchange ideas, and be exposed to cutting edge research. Locally, nationally and around the world, this pandemic has influenced us all in numerous ways, and we have different approaches and capabilities of how to respond. What unites us all is the determination to conquer this crisis and emerge as strong and perhaps, become more resilient individuals on the other hand. In this context, the conference theme, '*Bridging Knowledge and Experience to Combat Global Challenges*', has special significance for academics, researchers, practitioners and research students representing a wide spectrum of disciplines as it could provide the opportunity to discuss the potential of scientific research to minimize the current issues and challenges in the globe through workable solutions. Although the conference is held virtually, we believe we have created an exciting programme and conference structure which will, no doubt, stimulate interactive and meaningful discussion and participation of attendees from and around the world. This may enable all the concerned stakeholders to listen to different voices thus, better understand the ways in which theory, research and practice interact and inform each other.

In fact, Belihuloya where Sabaragamuwa University is located is a particularly appropriate place to celebrate the theme. We are confident that you will enjoy a stimulating conference and that your presence and participation will enrich discussions around the theme, developing professional knowledge exchange, insights and collaborations that may finally contribute to theoretical and empirical knowledge. We feel that we are not alone in our predicament and this gives us the strength to persevere. We wish you all an intellectual and transformative three days. Most importantly, the 02nd China-Sri Lanka Communication and Cooperation Forum is also held in parallel with ICSUSL 2021 under the theme, '*New Challenges and Opportunities for China-Sri Lanka Exchanges and Cooperation in the Post-Epidemic Era*'. We are grateful to Prof. Chen Xiangjun, the President, Huanggang Normal University, China and Youjie Zheng, the former Director, Confucius Center, Sabaragamuwa University of Sri Lanka for contributing financially to ICSUSL 2021 as a fulfilment of the Collaboration Agreement between Huanggang Normal University, China and Sabaragamuwa University of Sri Lanka.

Dr. Rohan Abeywickrama and Dr. Sarath Munasinghe
Co-Chairs of ICSUSL 2021

Keynote Address by Professor Lian Pin Koh

Nature-based Solutions: Promises and Pitfalls, and the Role of Science in Informing Sustainable Policies and Decisions

Achieving the Paris Climate Agreement target will require countries to implement changes to the policy and practices in agriculture, forestry and other land use activities, in addition to rapid decarbonisation. An integral part of achieving this is nature-based solutions (NbS), which include the conservation, restoration and improved management of forests, wetlands and agricultural lands to increase carbon sequestration, reduce CO_2 emissions, and enhance climate resilience. In this talk, Prof. Koh Lian Pin will discuss the promises and pitfalls of nature-based solutions and the important role that science plays to inform sustainable policies and decisions in nature-based solutions.

Prof. Lian Pin Koh
Professor of Conservation Science, Technology and Policy
Department of Biological Sciences
The National University of Singapore
Nominated Member of Parliament, Singapore

Keynote Address by Professor Chen Xiangjun

Poverty Alleviation in China: Contribution, Experience and Prospects

The eradication of poverty, building a moderately prosperous society in all respects, and realizing common prosperity is an important part of China's development process and a solemn commitment made by the Communist Party of China to the people of the whole country. China marched into a new era after the 18th CPC National Congress in 2012, and had made breakthroughs in poverty alleviation. At the important moment of the 100th anniversary of the founding of the Communist Party of China, victory in the battle against poverty is complete, and China completed the arduous task of eliminating extreme poverty. The historical process of the Chinese Communist Party leading the people in overcoming poverty can be divided into three stages: relief-based poverty alleviation (1949-1978), development-driven poverty alleviation (1978-2012), and targeted poverty alleviation (2012-2020).

Poverty alleviation at different stages is based on China's national conditions and it grasps the trends in poverty reduction in China. We have embarked on a path of poverty reduction with Chinese characteristics, formed the theory of poverty alleviation with Chinese characteristics, and accumulated valuable experience in eliminating extreme poverty. The great success of China's poverty alleviation cause is not only a direct response to the Chinese people's yearning for a better life, but also serves as reference for other countries to choose a suitable path of poverty alleviation, and offer China's approach to solving the problem of modern national governance and creating brighter prospects for social progress.

Prof. Chen Xiangjun
President
Huanggang Normal University
China

Address by the Guest of Honour

"Bridging Knowledge and Experience to Combat Global Challenges"

With 2021 drawing to a close, we are in a time of unprecedented change, and there is no prospect of easing in the pace at which the changes are taking place. The scientific, moral, and other arguments for robust reaction to that change have been set out by more learned people than me. So my focus is on how business must frame its response. Business is estimated in the OECD countries to account for 72% of GDP, and so what private enterprise does is important in managing any global situation.

The circumstances in which our global economic system was designed have changed vastly over the past century, and that change has accelerated in the last 2 years. That system contributed to the creation of the social, environmental, and health crises we see today. It needs to change, and the change we are seeing around us is the best catalyst for the change we need to see in business.

Capitalism is defined as the creation of value. Writing in the Wealth of Nations in 1776, Adam Smith explained that "a man must always live by his work, and his wages must at least be sufficient to maintain him. They must even upon most occasions be somewhat more; otherwise, it would be impossible for him to bring up a family, and the race of such workmen could not last beyond the first generation." He acknowledges that profit or self-interest must deliver wider benefit, yet that is not what happened as capital, disguised as globalization, pursued the lowest cost, compromising lives at home and abroad.

We should have listened to Smith, as we should have listened to Nicholas Stern when he presented the British Government's Stern review of the economics of climate change in 2006. Value is a multidimensional term. In its narrowest form, it is parasitic, but in its true form, it embraces people, the planet, and profit equally, and it is the most sustainable form of economic activity.

This is the framework for business in the new norm. It is different, but we must remember that the crises we are experiencing today were brought about by what we used to call normal. It was not normal for women, men, and children to suffer from inequality, lack of access to healthcare, nutrition, education, and economic opportunity. For the world to address the health, environmental, and social challenges we face today, businesses are obliged – morally, economically, ecologically, and practically – to actively adopt directions that have never before been a

part of the vocabulary of business. That direction is kindness – to people and nature.

Kindness to nature is the sustainable use of our natural resources. Those resources deliver the ecosystem services that make it possible for us to breathe, drink, cook, and bathe in water and also sustain our agricultural systems. Nature has value, but our economic system fails to recognize it because ecosystem valuation is a recent phenomenon with too few resources properly valued. Kindness to nature involves protecting the resources that will fuel our existence in the future.

Generally, kindness to people means paying a fair wage, sharing profits with the less fortunate, and caring for the elderly, children with different abilities, and the less fortunate. It is what gives a business a heart. Businesses comprise people and exist because of people, both workers, and customers. Kindness to people – addressing the gender gap as an example – is good from a moral perspective, and if that is not sufficient, it is also good from an economic one. It adds value to economies, strengthens the fabric of communities, and builds resilience.

Both people and the planet are critically important to businesses. The reasons for businesses to realign with the notion of creating genuine value in the social, natural, and economic dimensions are as much to build resilience, protect their existence, and satisfy growing calls for businesses to be kind.

If this sounds like wishful thinking, I can confirm its relevance to a Sri Lankan company, using Sri Lankan resources, embodying Sri Lankan kindness, and delivering Sri Lankan tea globally with a combination of faith, vision, determination, and purpose. Dilmah Tea began in my father's mind in 1950 as a desire to change the exploitative colonial economic system that extracted value from its stranglehold on tea. He fought against all odds, strengthened by his purpose and guided by his faith in God.

He launched Dilmah in Australia in 1985 and, since then, in over 100 countries around the world. Since 2004, his philosophy of serving humanity through business has delivered nearly Rs. 6 billion in humanitarian and environmental interventions in Sri Lanka. That philosophy demonstrates the natural role that a business has in addressing inequality, environmental conservation and restoration, and its compatibility with the commercial objectives of a business.

One Dilmah is not enough though, as the tea, coffee, and cocoa or chocolate categories around the world are characterized by vast revenue, substantial profits, and inequality and poverty amongst producers. The relevance of combining knowledge and experience to combat global challenges is as follows. The world has faced a multitude of challenges, but each has a solution. Nicholas Stern gave us one for climate change in 2006, and it would have saved a phenomenal number of lives and money if we had listened.

Science is helping us overcome the health crisis as we work towards building back better

through the opportunities that are at present and by doing well by doing good. These align with every positive indicator for the planet and its people. It was not always so. What could hold us back is a mindset conditioned by the past, and it is essential to remember that normal was never good. This is our greatest opportunity.

Without knowledge, there can be no progress because the achievement of genuine sustainability demands science and precision framed in technology, while the application of knowledge demands experience since change for the better in livelihoods and the environment cannot be achieved without collaboration.

Mr. Dilhan C Fernando
Chief Executive Officer - Dilmah Ceylon Tea Company PLC
Chair - Biodiversity Sri Lanka platform

The 2nd China-Sri Lanka Communication and Cooperation Forum

Along with the recent developments in China-Sri Lanka bilateral relations, there has been a rapid increase in the number of researchers conducting research on the new paradigm shifts of China-Sri Lanka relations. China studies, Chinese language and Sino-Sri Lanka relations have become key topics of interest for many researchers. The China-Sri Lanka Communication and Cooperation Forum was initiated in year 2019 as an annual research session organized by the Research Center for China-Sri Lanka Culture Exchange and Economic Development established at Huanggang Normal University. The research center was established under the MoU between Sabaragamuwa University of Sri Lanka and Huanggang Normal University, Huanggang, China. The primary objective of this forum is to serve as a platform for researchers in the two countries to disseminate their research findings on economic, cultural and language exchanges between the two countries, thereby strengthening bilateral cooperation between China and Sri Lanka. The first China-Sri Lanka Communication and Cooperation Forum was held from 6th-8th December 2019 at Huanggang Normal University in which a number of researchers presented their innovative research findings. Sabaragamuwa University of Sri Lanka and Huanggang Normal University take turns in hosting the event each year and the event is hosted by Sabaragamuwa University of Sri Lanka in 2021 in parallel with the 8th International Conference of Sabaragamuwa University of Sri Lanka.

Keynote Address by Professor Ye Hailin

Global Structure and Regional Order Transformation in Post Covid-19 Era

The outbreak of the COVID-19 pandemic worldwide in 2020 has been universally recognized as an unprecedented global public health emergency, which has caused extremely severe consequences in terms of world politics, economy and so forth. In the coming post-COVID era, it is expected that significant changes will appear in the Asia-Pacific region in the following three aspects, the regional power distribution, the regional order as well as the overall governing format. In terms of regional power distribution and regional order, as the strategic competition between China and the United States in several fields are getting more and more fierce, together with the fact that Asian emerging economics are destined to play an increasingly critical role in leading the global economic recovery process, the power resources within the Asia-pacific region will be prone to be shared by several parties, rather than be seized by one single state. In this way, it is the United States that has to seek cooperation, instead of confrontation with regional powers like China, if it is to maintain the overall stability and sustainability of the entire region. As for regional governing format, given the sharp contradictions of pandemic-control measures taken during the outbreak of the COVID-19 by China and some Asian countries, in comparison with most of the western countries, it is understandable that the independent and pluralism-oriented governing mode, which have been cherished by the majority of Asian countries for long, will continuously play an important role in the Asia-Pacific regional cooperation during the post-COVID era.

Prof. Ye Hailin
Research Fellow, Professor and Deputy Director General
National Institute of International Strategy (NIIS)
Chinese Academy of Social Sciences (CASS)

Keynote Address by Professor SUN Jisheng

Understanding the Belt and Road Initiative from the Perspective of Chinese Culture

Culture, accumulated and formed throughout a nation's development and history, directly influences a country's world view, the way of thinking and behavior, ideas and thoughts, values, norms, and habits. Chinese culture presents the follows features: wholistic and long-term way of thinking, the golden means and the interconnectivity and interchangeability between different things, and peace and harmony. The way that China implements the Belt and Road Initiative is also influenced by Chinese culture, which emphasizes equality, openness, inclusiveness, and development. It is promoting and will continue to promote the new round of globalization and common development of the world in the Chinese way

Prof. Sun Jisheng
Vice President
Professor of International Studies of China Foreign Affairs University
Secretary General of China National Association for International Studies
Deputy Editor-in-Chief of Foreign Affairs Review

New Challenges and Opportunities for China - Sri Lanka Exchanges and Cooperation in the Post - Epidemic Era

The Development of Sri Lankan English Drama in the 20th Century and the Enlightenment

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Based on the review of the history of Sri Lankan drama, this paper introduced Sri Lankan language policy and the special status of English language in Sri Lankan society, and then examines the evolution of English drama in Sri Lanka. From "Westernization" of the upper class and mocking the lower class, Sri Lankan English drama came to the shaping of national images and presenting Sri Lankan culture. The development of English drama in Sri Lanka in the 20th century brings us the following enlightenment: language is the carrier of artistic creation and the medium of artistic communication, taking foreign language as the carrier of artistic creation, adopting the artistic means and expression from foreign countries can serve the development of national culture and art. Making use of "the other" to realize "self-construction" is an effective way to pass on the excellent local culture in the era of globalization.

Keywords: *English Drama, Globalization, National Culture, Sri Lankan Drama*

Study on the Image Construction of China's Aid Construction by Chinese and Foreign Media under the Background of Belt and Road Initiative - Take Sri Lanka Port Project for Example

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By using news framework theory, the paper tires to make comparison of news reports related to China's assistance in the construction of Colombo port and Hambantota port selected from the mainstream media of China, American, India and Sri Lanka from 2015 to 2020. It is found that the image of China's aid construction in the media of four countries is different. Specifically, the image was covered negatively in American media while in Indian media, it was not portrayed as positive as the China-India friendship would imply. In view of the stigmatization of western countries on the image of China's construction assistance, it is necessary to expand China's influence in international foreign aid and build the image of a responsible great power. At the same time, China should enhance communication and cooperation with Sri Lanka under the Belt and Road Initiative, with the goal of bringing benefits to all.

Keywords: *Chinese and Foreign Media, Image of China's Aid Construction, Colombo Port, Hambantota Port*

On the Localization of Chinese Textbooks in Sri Lanka

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As an important resource in teaching, the importance of textbooks is self-evident. In this case, the traditional 'general' textbooks have obviously been unable to meet the needs of overseas learners, so 'localized' textbooks have become a new trend in textbook compilation. However, the quantity and quality of existing localized teaching materials are far from enough, especially for Sri Lanka, a country with a large number of Chinese learners. Therefore, it is urgent to compile a high-quality Sri Lanka localization textbook. Based on the localization of Zhou Xiaobing's Chinese textbooks, this study explores the differences between China and Sri Lanka from the aspects of language (pronunciation, vocabulary, grammar) and culture (social system, cultural customs, thinking mode, etc.), and provides reference for the compilation of localized Chinese textbooks in Sri Lanka.

Keywords: *Localization, Chinese Textbooks, Sino-Sri Lanka Differences*

Strategies of China-Sri Lanka Higher Educational Cooperation Under "the Belt and Road Initiative"

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The construction of the Belt and Road Educational Action promulgated by China's Ministry of Education and the Strategic Management Plan (2013-2017) implemented by Sri Lanka's Ministry of Higher Education provide a policy basis for educational exchanges and cooperation between the two countries. Based on the analysis of the scale and level, funding, institutional system and international demand of Sri Lanka's higher education, this paper points out the strategies of higher educational exchanges and cooperation between China and Sri Lanka, which includes attracting, cultivating or dispatching overseas students, cooperative running of schools and joint training of talents, setting up special projects of higher education to strengthen the connection between people, together with innovating cooperation models or mechanisms and deepening cooperation on scientific research projects. It aims at providing references for China's educational management departments and promoting the mutual prosperity of education in both China and Sri Lanka.

Keywords: *China and Sri Lanka, Higher Educational Cooperation, The Belt and Road Initiative*

An Assessment of the Contemporary China-Sri Lanka Socio-Economic and Cultural Relationship During the Pandemic Era

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China and Sri Lanka have strengthened long-run equilibrium relations over time and China is one of the major countries tremendously linked with Sri Lanka in terms of economic, religious cultural, social and diplomatic relations and these relations have been consecutively developed over a long period between China and Sri Lanka. The consequences of the Novel Coronavirus (Covid-19) have had multifaceted impacts around the globe economically, culturally, socially and diplomatically. The study aims to investigate the impact of Covid-19 outbreak on the socio-economic and cultural relationship between China and Sri Lanka in the present scenario. This study is primarily based on secondary data sources such as journal articles, WHO statements, Central Bank Reports of Sri Lanka (CBSL), Sri Lanka's State Pharmaceutical Corporation (SPC) etc. literature. Despite the negative impacts of the pandemic on both countries, this study has found out that the bilateral relationship between Sri Lanka has taken a new paradigm shift during the pandemic period. An outstanding socio-economic relationship between China and Sri Lanka has grown out of the challenges along with the assistance and donations provided by China for controlling and monitoring covid-19 in Sri Lanka. From the recent trends in the Sri Lanka-China relationship, it could be assumed that the bilateral relationship will continue to grow in time to come and the role of teaching Chinese as a foreign language in Sri Lanka will be a key factor behind future developments in this regard.

Keywords: *China-Sri Lanka, Socio-Economic, Culture, Relationship, Covid-19 Outbreak*

A Study on Cultural, Educational and Economic Changes in Sri Lanka due to the Influence of Sino-Sri Lanka Bilateral Ties

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Sri Lanka is a lower-middle income country with one of the highest per capita income in the South Asian region. Entrepreneurship results for venture creation with direct/ indirect employments that leads on economic development, accelerating the achievement of wider socio-economic objectives, including poverty alleviation, employment generation, income equality and foreign exchanges. Commercial Banks plays a pivotal role in economy while providing access to capital in various means to different sectors. The traditional financing methods has been replaced by informal sources due to inherited issues; high borrowing cost, long processing periods and high value securities. Further recent obstacles in the finance market create a question mark for the trustworthiness while think rationally on financing sources. Informal sources are more popular due to the simplicity of village lenders; personal securities ,less documentation and bureaucratic procedures even with high borrowing costs. Limited access to banking facilities, lack of regional spread of loan schemes or availability, afraid of using new technology tools or machines, lack of knowledge on banking procedures, and inability to provide collateral may cause for the less attraction of the formal finance sector when compared with informal sector. Research Objectives formulated to assess the impact of the formal financing dimensions and most and least important dimensions influencing regional entrepreneurs' formal financing decision. Sample consisted from 40 Entrepreneurs chosen by snow-ball sampling method in Uva province and in-depth interview method has been adopted for data collection. Quantitative methods as Correlation and Regression analysis adopted for analysis. Study reveals most entrepreneurs are unsatisfied with the available packages of formal finance institutes and Microenterprise dynamics are the best influencing dimension on the formal financial decisions. Permanence in the sector, Plans to expand Buying and selling procedure and Compliance with tax authorities are mostly affect to the entrepreneurs' formal financial decisions. As recommendations; relationship with entrepreneurs, locational advantage of finance institutions, focused promotion, public awareness, time of access , and reducing the formalities has been provided. Simplify/flexible the pre-requirements to obtain the lending facility and process to entrepreneur, and government facilitation on financial infrastructure and financial literacy has been highlighted as managerial implications.

Keywords: *Entrepreneurship, Financing decision, Micro finance, Informal Finance, Financial literacy*

A Study on China-Sri Lanka Education Exchange and Cooperation: With Specific Reference to Teaching Chinese at Confucius Classroom of Sabaragamuwa University of Sri Lanka

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Sri Lanka is an important hub in China's "21st Century Maritime Silk Road". The prompt propagation and development of Chinese language and Chinese culture in Sri Lanka plays a significant role in establishing friendly relations between the two countries. Along with the academic cooperation programme established between Huanggang Normal University and Sabaragamuwa University of Sri Lanka, Confucius Classroom of Sabaragamuwa University of Sri Lanka has played an important role in promoting the development of teaching Chinese in Sri Lanka since its establishment in 2019. The researcher has used literature study method to analyze China-Sri Lanka education exchange and cooperation in relation to the developments in the Chinese teaching practice at Confucius Classroom in recent two years, teaching staff, teaching environment, curriculum, use of teaching materials, conducting HSK examinations and cultural activities. The primary data were gathered through an online questionnaire. Through the analysis of the questionnaire survey results of Chinese teachers and 30 learners at Confucius Classroom, it is concluded that at present, Confucius Classroom still has deficiencies in making use of the resources offered by Chinese party. In teaching Chinese, improper course arrangements, insufficient use of teaching resources, insufficient localized teaching resources, unstable learning motivation and lack of organizing cultural events are considered as the key issues. The author has proposed several suggestions aimed at improving on the aforementioned shortcomings such as improving the curriculum, standardizing teaching management, scientifically using teaching materials, promoting Chinese courses for local community, enriching cultural teaching activities, and skillfully using mass media to promote the programs conducted by Confucius Classroom. It is expected that this study will be instrumental in bridging the gap in the current research on teaching Chinese in Sri Lanka.

Keywords: *China-Sri Lanka Cooperation, Teaching Chinese in Sri Lanka, Confucius Classroom, Sabaragamuwa University of Sri Lanka*

Main Characteristics of Sri Lanka's Vocational Education System and Its Enlightenment

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Sri Lanka has a relatively perfect vocational education system, which is mainly reflected in the high degree of national attention to vocational education, the diversification of types of vocational education institutions, the obvious guiding role of the national vocational qualification framework, and the strong support of vocational ability standards and curriculum system. The Enlightenment of Sri Lanka's vocational education system is as following: the first one is paying more attention to the construction of vocational education system; the second one is expanding the types of vocational education; the third one is to improve the national management system of vocational education qualification, and the fourth is to establish a clear vocational ability standard and curriculum support system.

Keywords: *Sri Lanka, Vocational Education System, Characteristics and Enlightenment*

The Chinese Experience in Tourism Poverty Alleviation in Sri Lanka Is to Be Learned From

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The core connotation of tourism poverty alleviation is to increase the income of the poor through the development of tourism industry, and to get out of poverty and get rich. By 2020, China will move from widespread poverty to the total eradication of absolute poverty, contributing more than 70% to global poverty reduction, of which 20% to 30% will come from tourism.In recent years, although Sri Lanka has entered the ranks of middle-income countries, the gap between rich and poor is wide, and poverty remains an urgent problem for Sri Lanka. Because of Sri Lanka's beautiful scenery and abundant tourism resources, the sustainable development of tourism can help people in poor areas of Sri Lanka out of poverty. Based on this background, this paper analyzes and collates the relevant information of Sri Lanka through the literature law, comprehensive generalization method, and so on, and clarifies the current situation of tourism in Sri Lanka and the problems existing in the process of tourism poverty alleviation, and finally puts forward corresponding suggestions for the cause of tourism poverty alleviation in Sri Lanka by drawing on the experience of China's tourism poverty alleviation.

Keywords: *China Experience, Sri Lanka, Tourism Poverty Alleviation*

Research on the Impact of Sri Lankan Language Policy on Its Ethnic Relations

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Language issues are one of the important variables that trigger social conflicts. The improper handling of the selection and promotion of national and official languages in multi-ethnic countries can easily lead to inter-ethnic conflicts, which will adversely affect the construction of harmonious ethnic relations. Sri Lanka is a multi-ethnic, multi religious and multi lingual country deeply under the colonial rule of the West. After its independence, in the face of the establishment of the national language and the official language, there were frequent ethnic disputes, even bloody conflicts and wars between Sinhalese and Tamil due to their respective language status issues. By analyzing the impact of the implementation and promotion of Sri Lanka's multi-ethnic language policy after independence on Sri Lanka's ethnic relations, this paper reveals that it is understandable for an independent country to choose one or more local languages as its national language according to its national conditions, whether as its symbol or ethnic language; However, the choice of national language and official language should be fully combined with the reality of the national language situation. In the process of its implementation, it can neither be forced nor rushed. From the perspective of building harmonious ethnic relations, multi-ethnic countries should respect and safeguard the language rights of all ethnic groups and adhere to the multilingualism policy in the process of promoting the national language and official language.

Keywords: *Sri Lanka, Language policy, Ethnic Relations*

The Impact of Business Environment on High Quality Economic Development: ACross-country Panel Data Approach

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Based on the panel data of 114 countries in the world from 2009 to 2017, this paper uses Tobit regression method to empirically study the impact of business environment on high-quality economic development. The results show that: from the full sample regression results, the total business environment index significantly promotes the high-quality development of the world economy; from the regression results of 10 sub indicators of business environment, except for the performance of contract indicators, other sub indicators also significantly promote the high-quality economic development; from the results of sub sample regression between developed and developing countries, business environment significantly promotes the high-quality economic development of developing countries, but has no significant impact on the high-quality economic development of developed countries. The policy enlightenment of this paper is that under the background of the new economic era, continuous optimization of business environment is an important focus to promote the high-quality development of China's economy.

Keywords: *Business Environment, Developed Countries, Developing Countries, High-quality Economic Development*

A Study on the Issues of Translating Chinese into Sinhala

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At present, as a result of strong ties between China and Sri Lanka, Chinese language has been assigned a prominent place in education and professional fields in Sri Lanka. When dealing with Chinese language for educational and professional purposes, Sri Lankans face many difficulties due to the cultural and language difference existing between the two countries. The objective of this study is to investigate the ways to improve the quality of Chinese – Sinhala translations by doing an analytical study of the problems and errors encountered when translating Chinese into Sinhala language. The primary data for the study was collected by giving a questionnaire to Chinese language students and Chinese -Sinhala translators, related research articles, journals and information in websites were used as secondary data. In translating from Chinese sources into Sinhala, lack of knowledge regarding cultural differences between two countries, tendency to translate using software applications, lack of interest in seeking new knowledge and lack of equivalent words in Sinhala vocabulary for Chinese terms and are identified as the key issues in translation and for reducing quality in translation. Translations done using software applications can be identified as a prompt method to obtain rough or short translations yet it cannot be considered as a suitable method to translate literary texts. This study reveals that quality translations and translators can be produced by bringing forth remedial measures for the above-mentioned problems by imparting the knowledge and formal training required for Chinese – Sinhala translation in Sri Lankan education system.

Keywords: *Chinese, Sinhala, Culture, Translation, Sri Lanka*

A Study on the Impacts of Social and Culture Exchanges between China and Sri Lanka through BRI on Sri Lankan Tourism

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China is one of the leading players in the current world power struggle owing to China's recent economic developments. The president, Xi Jin Ping has revitalized the concept "Old Silk Road" through the "Belt Route Initiative (BRI)" project which is currently being implemented with a new meaning. The BRI project will bring together the trinity of Europe, Asia, and Africa. In this process, Sri Lanka has a very important role. This project will benefit the financial development of Sri Lanka while providing the necessary financial assistance for infrastructure development. This study discusses the social and cultural exchanges between Sri Lanka and China as a result of BRI. When conducting the research, primary data were collected through interviews and secondary data such as reports, articles, and journals were also used. BRI promotes financial and infrastructure development as well as social and cultural exchanges. As a result of these social and cultural exchanges, we can clearly identify the development in educational exchanges, community exchanges, and tourism promotions in Sri Lanka. Most importantly, these social and cultural exchanges have been intertwined with economic and infrastructure development. Recent developments in bilateral cooperation are reflected in development of TCFL in Sri Lanka, increase in Chinese tourist arrivals to Sri Lanka and Establishment of Chinese cultural centers such as Confucius Centers in Sri Lankan Universities. It is also observed that there is a significant development in the interest to learn Sinhala in Chinese nationals during the recent years.

Keywords: *Belt and Road Initiative (BRI), Infrastructure Development, Silk Road, Social & Cultural Exchanges, Tourism*

A Study on the Contribution of China for Enhancing Quality of Chinese Language Degree Program in Sabaragamuwa University of Sri Lanka

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The popularity of the Chinese language has reached its climax with the rising number of investments in Sri Lanka by China. As a result, demand for learning Chinese has also increased among the local young generation. They are interested in learning the language to acquire better communication skills, expecting to market themselves in reputed professional bodies seeking fluent, competent Chinese communicators. To provide them with the necessary language knowledge and supply Chinese language speakers to the required industries, Sri Lankan higher educational institutes have started promoting Chinese as a Foreign Language. Sabaragamuwa University of Sri Lanka has also joined this journey for more than ten years. The Chinese Language degree program has undergone many revisions, which led graduates to become fluent, competent, and efficient communicators wherever they are rooted as employees. Taking this as an opportunity to promote and spread their language, China is giving its patronage well enough to comprehensively facilitate Chinese language learners and teachers. The main objective of this study is to find out the contribution given by China to enhance the quality of the Chinese language degree program at the Sabaragamuwa University of Sri Lanka. Based on online surveys, interviews, observation, and personal experiences, the study found out that China has given an immense contribution in diverse ways, such as establishing Confucius classroom and test center, providing volunteer native Chinese teachers, training for the preparation of the "Chinese Bridge Competition," granting scholarships to study in China for both local Chinese language teachers and students, donating relevant textbooks, organizing the Chinese language education-related cultural programs and initiating joint academic projects. Based on the results of the study, it is undeniable that the Chinese Language Degree offered by the Sabaragamuwa University of Sri Lank has benefitted a lot from China in various means.

Keywords: *Sabaragamuwa University of Sri Lanka, Teaching Chinese as a Foreign Language, Contribution of China, Enhancing Quality*

Conquer the Challenges in Agriculture for Global Food Demand

The global food system is expected to provide safe and nutritious food to the world population that will likely grow beyond 9 billion people in the coming decades. To meet the growing demand, agricultural productivity should increase through sustainable production. However, in the current scenario, the world faces challenges that jeopardize food security. Thus, improvements in agricultural efficiency are not enough to maintain a sufficient increase in crop and livestock production, as they are impeded by climate change, degradation of natural resources, loss of biodiversity, the outbreaks of pests and diseases and developed antimicrobial resistance in livestock. At the same time, globalization, technological advances, business and economic changes, and government policies are transforming entire food chains. Research findings leading to address those global issues in the areas such as Crop Production Technology, Crop Improvement and Plant Protection, Irrigation and Drainage Systems, Post-harvest Processing, Storage and Technology, Bioenergy, Agricultural Engineering, Animal Husbandry, Animal Health and Welfare, Aquaculture, Agricultural Environment, Agricultural Economy, and Agribusiness Management and Extension are henceforth included in this section.

Plenary Speech by Professor Md Solaiman Ali Fakir

Performances of Selected Underutilized Plants as Alternative Sources of Carbohydrate and Protein in Tropics and Subtropics

Major cereals (rice, wheat, and corn) rich in carbohydrates which are the staple food in many Asian and African countries could be supplemented by cheaper starch-yielding minor crops (cassava, quinoa, and buckwheat, etc.). The diet of the rural population in South Asian countries is usually deficient in quality protein. It can also be supplemented with minor plant products (beans and leaves of cassava, moringa, and sweet potato) that are enriched with balanced proteins, minerals, and other phytochemicals of various health benefits. The increasing population and rapid urbanization result in the decrease of cultivable lands in subtropical countries, including Bangladesh, which demands supplementary and cheaper sources of carbohydrates and proteins. In this perspective, some minor crops could be potential sources since they can be easily grown in the homestead and other unutilized lands which are not as competitive as lands occupied by cereals and high-value crops. Nevertheless, many neglected and underutilized species (NUS) are tolerant to abiotic stress and produce appreciable yields with little care and input. Such crops appear to be climate resilient and offer additional food and nutritional security in the regions. Our research has examined yield potential and developed product processing techniques of selected carbohydrate and protein yielding minor crops of tropical and subtropical countries.

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Agribusiness Management and Extension

Comparison of Agricultural Activities of Old and Young Vegetable Farmers in Polgahawela Divisional Secretariat Division in Sri Lanka

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Agriculture is one of the most dominant fields in Sri Lanka. Improving agri-entrepreneurship of farmers is a good solution to enhance the efficiency and effectiveness of agricultural activities. Nowadays, although old as well as young people are engaged in farming, there are differences between them. Therefore, the aim of the study was to compare and contrast the differences between old (>40 years) and young farmers (≤40 years) in relation to knowledge factors, entrepreneurial skills and agriculture performances. Polgahawela Divisional Secretariat (DS) Division in Kurunegala district was the study area. Five Grama Niladari (GN) divisions were selected randomly and then hundred farmers were selected randomly as twenty vegetable farmers (10 old farmers and 10 young farmers) from each selected GN division. Researcher administered questionnaire was used from 20th July 2020 to 20th October 2020 for the data collection. Reliability Analysis, Independent sample *t-test*, *Chi-square* analysis were used as data analytical techniques. Difference of farmers in relation to knowledge factors was tested by applying *Chi-square* analysis. Difference of entrepreneurial skills and performance between young and old farmers was analyzed by independent sample *t-test*. According to the results, knowledge factors varied between old and young farmers. While young farmers used ICT (frequently-24%, average-44%), old farmers were not willing (92%) to use ICT for farming. Young farmers were higher in education level than old farmers. However, the old farmers had more experience than young farmers. Extension programs were followed by old farmers more than young farmers. Entrepreneurial skills and performance were different between old and young farmers, and old farmers had more skills and performance than young farmers. Thus, both groups of farmers have some positive as well as some negative aspects. Therefore, these differences are needed to be considered in conducting agricultural development and extension programs in this area.

Keywords: *Agriculture, Entrepreneurial Skills, Farmers, Agriculture Performances*

Customer Perception and Attitude towards Value-added Products of Potato Varieties Grown in Sri Lanka

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With busy lifestyle, people are more concerned on ready-to-eat food with a good nutritional value. Therefore, food products upgrading is very important. Potato (*Solanum tuberosum*) being a perishable product, long-term storage is difficult. Hence, value-addition of potatoes would enhance the shelf-life, market value, nutritional value and farmers' income. This research study analyzes the customers' buying behavior on imported, value-added potatoes available in the market and identifies the feasibility of marketing locally-grown, value added potatoes. An online survey was conducted for the data collection from 25/01/2021 to 10/02/2021 by 155 respondents. The data were analyzed using descriptive statistics. With regard to imported value-added potatoes, majority of respondents (78.0%) are willing to purchase them. The most significant reason is its fried taste (89.7%). The main reason of the rest of the respondents for not to purchase was their unwillingness to eat already processed food. The association between willingness and availability of value-added potatoes was statistically significant emphasizing the importance of product accessibility. Respondents in the age group of 20-25 years were stimulated in purchasing and with aging, willingness has declined. The most popular brand was "Pringles" while original potatoes fancied over flavored. Moreover, in focusing the perception towards value-added locally grown potatoes, the belief on healthiness and nutrition of value-added potatoes was high. Out of the total, 87.2% of respondents wish to purchase locally-grown value-added potatoes to save foreign exchange and 76.07% were interested in purchasing locally-grown, recommended raw potatoes for value-addition at home. Accordingly, maintaining the original fried taste of the potatoes, developing minimal processing techniques and sustaining nutritional attributes is required. Market availability of quality value-added potato products is essential to enhance customer purchasing. Growing suitable varieties will provide farmers with double benefits of value addition and selling branded varieties since there is a potential demand for locally-grown potato varieties in the market.

Keywords: *Customer Willingness, Locally Grown, Market Availability, Potato Varieties, Value-Addition*

Effects of Sample Volume on Sensory Perception of Soya Milk

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Food consumption is involved with complex of dynamic process. Food can be taken into the mouth of an individual in various quantities. The quantity depends on the bite size and the type of utensil used. The amount of food that is taken each time in the mouth is highly variable between consumers to detect its sensory attribute. Sensory perception of food items differ from person to person. Presentation order and preceding samples are known to influence the perception of sensory attributes. The present study was designed to evaluate the effect of sample volume on sensory perception of food. A semi trained panel of fifty subjects were asked to rate some sensory attributes of commercially available soya milk. Stimuli were placed in plastic cups in 10 ml, 20 ml and 35 ml. Participants were allowed to sit comfortable in the sensory booth with appropriate ventilation and lightning. The participants were asked to sip the milk provided and mark the liking on a line scale. The scale ranges between 0 - 100. The panelists were requested to rate the smoothness, sweetness, flavor and after taste characteristics of the plain and flavored soya milk. According to the test, the sweetness perception of the flavored soya milk took more volume to detect the taste. Other characteristics were detected with the less volume of milk presented. From the study it can be concluded that the serving size had no effect on the sensory perception of soya milk except the sweetness perception of flavored soya milk ($p=0.02$). Intake of food in mouth can be varied with the nature of food, familiarization of food and mental condition of panelists. This study can lead to give a clue to the food processors to determine the bite size of a food product they are producing.

Keywords: *Sensory Perception, Soya Milk, Sweetness, Sample Volume*

Evaluation of Effectiveness of Training Programmes for Technicians in Land Preparation of Rubber Farming: A Case Study in Kegalle District

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Scarcity of skilled technicians in Land Preparation of Rubber Farming (TLPRF) was identified as one of the major reasons which affect the sustainability of the rubber sector in Sri Lanka. Hence, establishment of training programmes for TLPRF called "*Erambumata Athwelak*" (EA) in rubber growing areas is the extension strategy introduced by the Rubber Research Institute of Sri Lanka (RRISL) to overcome this issue with the intention of introducing technically skilled personnel to perform according to the recommendations of the RRISL. Systematic training through the EA was initiated in 2012 with the aim of enhancing the knowledge and skills of Land Preparation of Rubber Farming (LPRF). Subsequently, a case study was conducted to evaluate the EA for further improvement in the efficiency and effectiveness of EA. Sixty trainees and non-trainees were evaluated using a questionnaire on practical aspects. The level of skills LPRF of TLPRF was measured by practical test. The increase in skill due to EA was statistically significant. The respective mean scores for trained and non-trained groups for skills 74 and 38 ($t=-12.85$, $P<0.001$) signifying that training has increased skills by 74%. The experience in harvesting was negatively correlated with skill level ($r=-0.528$, $P<0.001$). Participation in other rubber related training programmes was positively related with skill ($r=0.341$, $P<0.01$). The variables, such as age, gender and education level and job satisfaction did not have significant relationships with skill level of LPRF. It is evident that systematic training enhances skill on LPRF, eventually improves the productivity of rubber holdings. Hence, this practice is worth continuing for the future for the improved performance of the rubber sector.

Keywords: *Preparation of Rubber Farming, Rubber Sector of Sri Lanka*

Factors Affecting for Potential to Adopt Five-Star Certification: Case Study of CDA Registered Small and Medium Scale Oil Millers in Kurunegala District

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Adulteration of Coconut (*Cocos nucifera*) oil is very high due to lack of proper certification for quality raw materials, improper maintenance of standard production process, physical, chemical, microbiological tests for quality determination and less attention for using labelled products. This study was aimed to identify the relationship between factors affect on small and medium scale oil millers' willingness to adopt five-star certification. Accordingly, a questionnaire survey was conducted to collect primary data from the millers in Kurunegala district. In addition, coconut oil samples derived from two processing methods (Virgin and normal) were collected from factories production and analysed after storing 3 months under room temperature of 31°C. Consequently, their physical properties (moisture content at 105°C, Lovibond colour), chemical properties (Free fatty acids, peroxide value, Iodine value, Saponification value), and microbiological properties (Aflatoxin level) for the final product was determined. Survey Physicochemical and microbiological properties were analysed using 1 sample t test, 2 sample t test by MINITAB17. The results of binary logistic regression analysis exposed that there is a positive and significant impact of product and processing ($p<0.01$), awareness of coconut oil production ($p<0.05$), procurement practices of raw materials ($p<0.05$), factory and surrounding characteristics ($p<0.05$), equipment and machinery ($p<0.05$), documentation ($p<0.1$) on willingness to adopt 5-Star certification. A significant difference ($p<0.05$) was observed in colour, moisture, iodine value, peroxide value and Aflatoxin level of coconut oil; while free fatty acids level and saponification value are not significant at 0.05 level of significance. There is a positive relationship between quality management practices and chemical parameters. The study recommends improving the promotion of CDA certification as a mandatory requirement to ensure quality of coconut oil to ensure for consumers.

Keywords: *Coconut Oil, Five–star Certification, Kurunegala District, Willingness to Adopt*

Marketing Methods and Chains of the Maldive-Fish Processors: A Case Study in Matara District

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The Maldive fish industry is quite popular among small scale processors, mainly females, who have settled along the coastal belt in southern Sri Lanka. The efficient marketing system is important considering the local marginal Maldive fish industry in both the consumers and producers. However, marketing aspects are remains neglected and exploitation of the producers in hands of intermediaries is identified in marketing chains. The economic statistics and marketing status are usually not well documented and inadequately reached. Therefore, this study aims to examine different marketing chains, market margin and marketing methods used by Maldive fish processors toward policy measures. Devinuwara, Mirissa and Gandara in the district of Matara were selected purposively. In-depth interviews with processors (n=20) and traders (n=15) were selected by using simple random and snowball sampling methods respectively. Results revealed that 40% of Maldive fish processors add cinnamon/gamboge/curry leaves and large scale processors (8%) add Sodium Benzoate and citric acid to the boiling water while others (52%) not add any ingredients to improve the product physical quality. Processors sell products in bulk (92%) and other (08%) forms as loose flakes, bottled flakes, and broken splits while 20% sell packed products. In addition, 50% of the processors sell products to traders who come from outside Matara. The 8% of processors use social media and posters as their marketing techniques, while others (92%) use word of mouth. There are four major marketing chains and majority processors (80%) sell to consumers through the wholesalers and retailers. The market margin is estimated at 55% for the major marketing channel. The profit share of producer, wholesaler and retailers are 9.25%, 35% and 20% respectively. It is evident that the processors are not making a reasonable profit through the marketing channel and the marketing methods in the region are inefficient. Therefore, an effective policy for a transparent marketing system is recommended to uplift national economy through the production and trade enhancement.

Keywords: *Maldive Fish, Marketing Chains, Marketing Methods, Profit*

Need of Agricultural Information and their Accessibility for Women Farmers in Imbulpe DS Division in Sri Lanka

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The need of agricultural information and accessibility for farmers are more crucial for enhancing the food production. Therefore, this research was conducted to study the agricultural information needs and accessibility for women farmers in Imbulpe DS division in Rathnapura District. Out of the women farmers of the area, 238 were selected through simple random sampling method from purposively selected seven Grama Niladhari (GN) divisions. Pre-tested, interviewer-administered questionnaire survey was used to collect data from March to July 2019. Descriptive statistics and chi-square analysis were used for data analysis. Based on the findings, most of the women farmers were within the age group of 40 - 59 years, married, and studied up to secondary education. Women farmers were undertaken production, processing, technology and marketing of agricultural products in this area. Most of the women farmers showed that they need more information regarding improved crop varieties. The lower level of agricultural information needs was showed for suitable storage facilities. About 60.5% of the respondents indicated higher level of agricultural information accessibility on improved crop varieties related to the production factors. Moreover, low level of agricultural information accessibility was shown regarding the improved market systems under the marketing factors. Extension agents were their major sources of agricultural information and ICT tools were the least important agricultural information source. Age, marital status, educational level and monthly income showed strong positive association with the agricultural information accessibility. A moderate level of positive association was obtained between farm land size and the agricultural information accessibility of this area. Therefore, enhancement of agricultural information accessibility by organizing awareness programs and extension services for the women farmers, enhancement of accessibility for market information through ICTs and encouragement of women farmers' participation in the farming societies of Imbulpe area will be very important to develop the agricultural information accessibility furthermore.

Keywords: *Accessibility, Agricultural Information, Needs, Sri Lanka, Women Farmers*

Sri Lanka's Potential Vegetable Export Flow and Its Determinants: The Gravity Model Approach

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The vegetable sub-sector is the most important non-plantation aspect in Sri Lanka's agriculture next to rice. With the available resources and weather conditions, Sri Lanka is having a potential to expand vegetable production and exports contributing to raise national income and heal the trade deficit that suffer the economy over decades. The primary objective of the study is to analyze the macroeconomic nature of Sri Lanka's vegetable exports by assessing the impact of different factors influencing exports. The analysis has employed panel data of 80 partner countries for a 27 year period from 1990 to 2017. Gravity model, an ideal tool to analyze bilateral trade has been involved for the analysis in an augmented form. Results suggest that the economic sizes of Sri Lanka and its trading partners have a positive effect on vegetable exports. Increase in the partners' populations has an unexpected negative impact. That implies the incompatibility between Sri Lanka's vegetable products and the changing demand patterns of growing international markets. The geographical distance between the countries and tariff rates exert a negative effect as expected. Domestic fixed deposit interest rates and weather fluctuations are estimated to decrease the exports. International trade agreements between Sri Lanka and trade partners positively trigger exports. As the second step of the study, the export potential is estimated by the ratio between predicted and actual quantities of vegetable exports. Sri Lanka has exhausted trade potential to 50% of the countries and still, there is a good trade potential for 48.33% of countries. Countries with good trade potential are found in all the geographical regions except the Oceania region. As suggested by the outcome; product diversification, value addition, analyzing international demand behaviors and introducing modern cultural practices are feasible modifications to induce vegetables exports.

Keywords: *Export Potential, Gravity Model, Panel Data, Trade Deficit*

Total Factor Productivity Growth in Sri Lankan Tea Estates: A Stochastic Frontier Approach

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This paper applied a stochastic frontier model to measure total factor productivity growth, technical efficiency change, and technical change in tea production in the estate sector in Sri Lanka using data from 35 tea estates relating to the period 2005 to 2019 which amounted to 4842 valid data points. A Translog Production Frontier was estimated since it was the best fit for the data. Labour (3.006) and extent (1.844) have the largest output elasticity and therefore, they can be regarded as the most important factors for tea production. However, fertilizer (0.032) and chemical (0.018) elasticities showed a value less than one, indicating an inelasticity. These low partial elasticities show that the use of these inputs has not been able to increase production at greater levels. Further, results revealed that the tea estate sector is 51.7% technically efficient which means that on average a typical tea estate had operated 48.3% below the potential output, indicating possibilities of increasing performance without any significant changes in inputs. Further, the results revealed slight technical progress during the study period and the overall rate of technical progress was estimated at 2.00×10^{-5} percent per year. Further, the overall rate of technical efficiency change declined, estimated at 1.19×10^{-5} percent per year. The combined effect of slow technical progress, dominated by the fall in technical efficiency resulted in the decline in the total factor productivity at a rate of 9.18×10^{-7} percent per year. This net effect of declining total factor productivity further raises serious concerns regarding the sustainability of the tea sector in Sri Lanka in the long run. Policies to shift the production frontier and improvements in managerial practices to combat declining efficiency levels are recommended.

Keywords: *Stochastic Frontier Approach, Tea Estate Sector, Technical Efficiency, Technical Change, Total Factor Productivity Change*

Tragedy of the Commons: The Case of Irrigation Water in Sri Lanka

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In Sri Lanka, irrigation water is treated as a common pool resource and one of the common issues of irrigation water in Sri Lanka is tragedy of common. The tragedy of the commons is an economics problem in which every individual has an incentive to consume a resource, but at the expense of every other individual - with no way to exclude anyone from consuming. Farmers in Sri Lanka generally enjoy free-of-charge irrigation facilities that are often provided by the government at zero -price mainly for water intensive paddy production. Practically it is impossible to expect economically efficient way of factor usage among paddy cultivation and this zero-price policy leads to uneconomic use of irrigation water, water inequality and mismanagement of water. Therefore, the main objective of this research is to measure the actual water usage for paddy farming at different water risk in the dry zone of Sri Lanka. Primary data were obtained from 360 paddy farm plots from *Rajanganaya*, *Nachchaduwa* and *Huruluwewa* irrigation schemes covering upstream and downstream farmers. Daily actual water usage at plot level was measured by volumetric method. Under this method water is collected in a container of known volume and the time taken to fill the container is recorded. Water responsiveness functions at different water risk were measured using classical cubic form production function approach. According to our study, on average, in the wet (*Maha*) season upstream farmers of *Rajanganaya* have used 4.8-acre feet (5921 cubic meter) and *Huruluwewa* upstream farmers 4.2-acre feet (5181 cubic meter) for paddy farming. Though water usage of *Raganganaya* farmers were 14% higher than that of *Huruluwewa* farmers in the wet season, the productivity variation was insignificant between two farmer groups. However, the downstream disparity of water usage in the dry season (*Yala* season) is much higher than the wet season. In the dry season, downstream farmers of *Rajanganaya* have recorded 5.7 acre feet and *Huruluwewa* downstream farmers have managed with 3.2 acre feet due to scarcity of water in the dry season. Even though water usage of *Rajanganaya* farmers were 78% higher than that of the *Huruluwewa* farmers, the productivity of paddy in *Rajanganaya* farmers were only 20% higher than the *Huruluwewa* farmers in the dry season. In the dry season, *Rajanganaya* farmers and *Huruluwewa* farmers have used 2950 liters and 2485 liters respectively for producing one kg of paddy. It is evidence from results that free provision of irrigation water leads to over exploitation and irrigation scarcity leads to efficient utilization of irrigation water.

Keywords: *Dry-Zone, Irrigation Management, Production Function Water Inequality*

Agricultural Engineering

An Android Application Based Mobile Phone Camera Colorimeter For Determining Soil Nitrate And Phosphorus

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There are different types of soil nitrate and phosphorus testing methods currently used in laboratories. However, most of the methods are expensive and require skilled labor. Also, not all agricultural soils in Sri Lanka can be tested by limited laboratory facilities. In the current study, a mobile phone camera-based colorimeter was developed for testing soil nitrates and phosphorus. The core of this method was the ability of a mobile phone camera to detect red, green, and blue colors (RGB) in a specific colored solution. The soil was reacted with specific chemicals and colored solutions were obtained. A special light box with a 5W LED lamp was made to hold the samples while receiving RGB readings from the solutions. An Android application named Color Grab was used to identify the RGB values in each sample. RGB values and absorption were measured for a standard solution series of nitrate (0 ppm to 50 ppm) and phosphorus (0 ppm to 0.5 ppm), and the calibration curves were plotted. Fifteen soil samples from different locations were tested by mobile phone camera and established spectroscopic methods, and the correlation between the two methods was compared. The results obtained from the proposed camera-based colorimetric method agreed well with the standard spectroscopic method. Therefore, this mobile phone camera-based colorimetric method could be used as a fast, cheap and simple way to test soil nitrate in 0 - 70 ppm range and soil phosphorus in 0 - 0.6 ppm range. Dilution should be done for higher nitrate and phosphorus soils.

Keywords: *Colorimeter, Nitrate, Phosphorus, RGB Values*

Assessment of Drought Impact on Paddy Production in Ampara District using Standardized Precipitation Index (SPI)

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Drought, described as a prolonged period of receiving insufficient rainfall, has a significant impact on paddy production. The objective of this study was to assess the impact of agricultural drought on paddy production in Ampara district using the Standardized Precipitation Index (SPI). Rainfall and temperature data for the 1990 - 2020 period from six weather stations (i.e., Malwatta, Ampara Tank, Pottuvil, Sagaman Tank, Maha Oya and Irakkamam) in Ampara district, as well as annual paddy yield statistics from 2000 to 2020, were collected. The Mann-Kendall test and Sen's slope estimator were used to assess the trends of annual rainfall variability over 31 years. Drought occurrence was assessed using the SPI for standard periods. Yield prediction models were developed using Standardized Precipitation Index (SPI) values and temperature for *Yala* and *Maha* seasons. To generalize SPI values across the study area, inverse distance weighting (IDW) interpolation was employed in ArcGIS software. Results revealed that the annual rainfall variability at five sub-weather stations showed no growing or decreasing trend from 1990 to 2020, except Mahaoya. There were 380 and 174 drought events with duration of 3-month and 6-month, respectively. In 2012, there was an extreme drought near Pottuvil area, and in 2019, near the Mahaoya area. According to the regression analysis, mean annual temperature and SPI had a significant effect on paddy production in Ampara district ($p<0.05$). However, the yield prediction models with SPI and temperature products had low R2 values of 37% and 45% for the *Yala* and *Maha* seasons, respectively, suggesting that more other predictors should be incorporated in future studies to increase model accuracy. Paddy production over 20 years showed positive and negative correlations with SPI at 6-month time scales during the *Yala* and *Maha* seasons, respectively. Overall, both drought and rising temperature have caused detrimental impacts on paddy production in Ampara District. Decision-makers should consider adaptation and mitigation strategies to address these challenges.

Keywords: *Ampara District, Drought, Paddy, Rainfall, Standardized Precipitation Index*

Elevated Arsenic in Soil Affects the Trace Elements in Rice (*Oryza sativa L.*) Grains

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Arsenic (As) contamination in soil has risen interest dramatically in recent decades. Although soils of Sri Lanka contain little amount of geogenic arsenic, agricultural practices such as fertilization, pesticide application, and irrigation are primary sources of As in the soil. Those who rely on rice as their primary source of nutrition may experience serious health consequences if rice grains are contaminated with As. A poly-tunnel experiment has been carried out to investigate the hypothesis that As contamination of soil affects the content of other micronutrients in rice grains. A two-factor factorial experiment was carried out adding 10 mg kg^{-1}As into the soil with controls (0.60 mg kg^{-1}As) and planting ten rice varieties. The amount of trace elements in unpolished rice grains was quantified by ICP-MS. The findings of this study showed that Zn and Fe concentrations in grains were lower in As contaminated soils, with an overall reduction of 7 and 14%, respectively. Other essential trace elements such as Mo, V, and Ni accumulations were reduced by 8, 12, and 34% under the elevated As condition, respectively while Mn contents were increased by 6%. Cu and Co contents in grains were not observed any difference between As added condition and controls. In addition, non-essential trace elements, including Al, Rb, Ba, and Sr accumulations, were reduced by 23, 34, 37, and 13% in the elevated As condition, while Li was increased by 9%. However, the soil As level only had a significant impact on Ni, Rb, and Ba accumulations ($p<0.05$). These findings suggest that As have a major role in other nutrient uptake and partitioning into the grain.

Keywords: *Elevated Arsenic in Soil, Micronutrients and Non-essential Elements in Rice Grains*

Crop Production Technology

Alternative for Polypropylene Bags in Oyster Mushroom (*Pleurotus ostreatus*) Cultivation in Sri Lanka

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Oyster mushroom (*Pleurotus spp.*) is a commercially significant, predominantly grown mushroom variety in Sri Lanka. Oyster mushrooms are currently grown in polyethylene bags commercially. At the end of the cultivation period, polypropylene bags are thrown out, as bags cannot be reused for the next season. This practice causes serious environmental pollution in Sri Lanka. Therefore, the present study was carried out to find a suitable substitute for polypropylene bags in Oyster mushroom cultivation. The experiments were conducted at the mushroom unit in Udathenna Matale. The experiment was laid according to Complete Randomized Design (CRD) using 4 treatments with 5 replicates. Treatments were: 15 cm height and 8 cm diameter polypropylene bags (T1), 15 cm height, 8 cm diameter glass bottles (T2), wooden trays (90× 40×12cm) (T3) and plastic crates (60×40×12cm) (T4). The substrates contained the department of agriculture (DOA) recommended ingredients including sawdust (125kg), rice bran (12kg), soya bean (1.2kg), mung bean flour (1kg), calcium carbonate (2.4kg), and Magnesium sulfate (250g). Results revealed the least time taken to spawn running was in T2 and T1 (22 days) the highest time was in T4 (26 days). The least time taken for pinhead formation was in T2 and T1 (27 days). The least time taken for the first flush was in T2 and followed by 57 days in T4. The minimum time taken for the first harvest is 54 days from inoculation in polypropylene bags and 52 days in glass bottle containers. Moreover, there was no significant difference between T1 and T2 on spawn running, pinhead formation and first harvest. Hence, glass bottles can be recommended as a substitute for polypropylene bags since T1 and T2 gave a great biological efficiency (BE%) than the wooden trays and plastic crates.

Keywords: *Environmental Pollution, Mushrooms, Plastic Crates, Reusable Glass Bottle, Wooden Trays*

Eco-Friendly Approach For Rice Weevil (*Sitophilus oryzae*) Management Using Clove (*Syzygium aromaticum*) Stem And Leaf Essential Oils

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The post-harvest loss of rice during the storage due to insect infestation, particularly by rice weevil (*Sitophilus oryzae*) and utilization of synthetic insecticides for such pest management are two major concerns in many tropical countries including Sri Lanka. Therefore, this study aimed to evaluate the potential of clove (*Syzygium aromaticum*) stem and leaf oil to control the rice weevils as an eco-friendly approach. The contact repellent activity of extracted oils was evaluated using 10 adult weevils of 10-14 days old, adopting to area preference bioassay. Five doses (15, 25, 50, 75, 100 µL) were used as treatments with water as the control. Numbers of insects settled on treated and control half of the filter paper were counted for every hour for five hours and percentage repellency was calculated. The fumigation toxicity test was performed using plastic vials containing 10.00 g of rice and filter paper strips treated with oil doses 25, 50, 75, 100 µL were attached at the top of the vial for fumigation. A group of 10 adult weevils were tested and all the tests were triplicated. The mortality percentage was computed after five days of exposure period. Among the essential oils, stem oil had a significant effectiveness in both repellent and toxicity activities. All the doses except 15 µL of stem oil showed more than 50% of repellent effect even after the first hour of exposure while the 100 µL showed the highest repellency (100.00±0.00) after three hours of exposure. Only, the 100 µL dose of leaf oil exceeded the 50% repellent effect after five hours of exposure. The highest mortality was observed in stem oil with 100 µL dose (96.67±3.33) while 50 and 75 µL doses caused similar mortality (83.30±3.33) after five days of exposure. Hence, the results indicated that stem oil was the most effective eco-friendly alternative for rice weevil management.

Keywords: *Essential Oils, Sitophilus oryzae, Syzygium aromaticum, Repellency, Toxicity*

Effect of Spacing, Gibberellic Acid and N: P2O5: K2O Ratio on Growth, Yield and Tuber Shape of Potato Variety Royal

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Potato variety ROYAL is suitable for French fries which require long-oval shaped tubers to minimize wastages in processing. Tuber yield and quality depend on N:P_2O_5:K_2O nutrient ratio and their amounts. Two field experiments were conducted in Nuwara-Eliya using variety ROYAL (a) to evaluate the possibility of changing tuber shape by manipulating spacing and gibberellic acid (GA3) application and (b) to identify the best N:P_2O_5:K_2O ratio to optimize growth and tuber yield. The first experiment was conducted as a two-factor factorial randomized complete block design (RCBD): factor 1 was intra-row spacing (15, 20, 25, 30, and 35 cm) and factor 2 was GA3 concentration (0, 150, 200, and 250 ppm; foliar-applied at bulking stage). Inter-row spacing was constant as 45 cm. In the second experiment, Agriculture Research Station, Seetha-Eliya recommended N:P_2O_5:K_2O ratio (8:3.5:8.5) with organic manure (T1; Control) and the same without organic manure (T2) were compared with three other N:P_2O_5:K_2O ratios (T3 - 12.5:21:12, T4 - 9:19:12 and T5 - 9:10:16:1 with MgO) in a RCBD. Organic manure was applied at the rate of 25 t ha^{-1}. In both experiments, 4 replicates were used. Spacing and GA3 interaction was not significant ($P>0.05$) for tuber yield and shape. The yield per plant increased as intra-row spacing increased but the yield per unit land area decreased with increasing spacing. GA3 effect on tuber yield was insignificant ($P>0.05$). GA3 at 200 ppm recorded the highest number of long-oval shaped tubers (62% increment). The ratios of N:P_2O_5:K_2O considered had no ($P>0.05$) significant effect on growth, yield, and quality. Therefore, a fertilizer ratio with low nutrient input (T5) will be a better option as it is cost-effective and environmentally friendly. Moreover, closer intra-raw spacing (15 cm) with 200 ppm GA3 can be recommended for higher yield per unit land area with more long-oval shaped tubers.

Keywords: *Fertilizer, GA3, Growth Hormone, Long-oval Shape, Plant Density*

Evaluation of Growth and Yield Performances of Two Potato Varieties, CONNECT and MASAI under Different Levels of Nitrogen Fertilizer

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Under Sri Lankan conditions, potato is extensively grown in Nuwara-Eliya and Badulla Districts. Although a fertilizer recommendation by the Department of Agriculture is available for potato, farmers do not comply with it. Instead, fertilizers are overused in up-country in many instances causing economic losses, and health and environmental issues. However, there are high nitrogen (N) efficient potato varieties such as CONNECT and MASAI that produce optimum yield under lower N but show abnormalities under higher N applications. A field experiment was conducted in Nuwara-Eliya to identify the effective N level to optimize the yield and quality of CONNECT and MASAI varieties. The experiment was arranged in a Randomized Complete Block Design (RCBD) with five N levels (110, 150, 190, 230, and 270 kg ha^{-1}) and replicated thrice. The N level of 230 kg ha^{-1} was the N recommendation of the Agriculture Research Station, Seetha-Eliya, while 270 kg ha^{-1} was a rate applied by some farmers. Phosphorus (100 kg ha^{-1}) and potassium (250 kg ha^{-1}) levels were kept constant with all treatments. Nitrogen level had no significant ($P>0.05$) effect on tuber yield or dry matter content in both varieties meaning that the yield was not affected even by the lowest N level used. The potato yield ranged from 22.54 to 25.67 and 13.62 to 19.66 t ha^{-1} in CONNECT and MASAI, respectively. In MASAI, 110 kg ha-1 of N recorded the highest number of tubers (6.5 $plant^{-1}$), whereas 230 kg ha-1 recorded the lowest (4.1 $plant^{-1}$). The N level had no significant ($P>0.05$) effect on the number of tubers in CONNECT. In conclusion, the lowest N level (110 kg ha^{-1}) can be recommended for MASAI and CONNECT potato varieties as it is an economically and environmentally sound option which did not cause any yield or quality reduction in the present study.

Keywords: *CONNECT, Fertilizer, MASAI, Potato, Tuber yield*

Optimizing the Composition of Biological Yield to Enhance the Productivity of Cinnamon Plants

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Being one of the major export agricultural crops in Sri Lanka, cinnamon contributes largely to the country's economy. But the export income obtained through cinnamon is much lower than the potential value due to numerous reasons and low productivity of cinnamon lands is one of them. The productivity of cinnamon lands can be enhanced by increasing the productivity of single plants. The knowledge on biological yield and its composition is crucial to enhance the individual level of productivity. Hence, the study was conducted to optimize the biological yield composition through optimizing spatial pattern, type of planting material and harvesting interval in order to enhance the productivity of cinnamon plants. Seedlings and vegetatively propagated plants of cinnamon; variety Sri Gemunu were planted under three spatial patterns as (A) 1.2×0.6 m with three plants per hill, (B) 1.2×0.4 m with two plants per hill and (C) 1.2×0.2 m with one plant per hill at the Faculty of Agriculture, University of Ruhuna, Sri Lanka. Stems were harvested in two planting intervals as 6 and 8 months. The study was conducted after four years from field establishment. Plants were removed above ground level and samples of separate plant parts (leaves, bark, stem, scrape, un-peelable portion of the main stem and secondary branches) were oven dried at 105 ^{0}C to a constant weight and percentage dry weight of each plant part comparative to the total plant dry weight were calculated. The results revealed that, interaction effect among 3 factors was not significant ($P<0.05$) for composition of biological yield. Only the interaction effect between spatial pattern and planting material were significant for the percentages of leaves, stem, scrape, un-peelable portion of the main stem and secondary branches ($P<0.05$). The treatments tested did not have any significant ($P<0.05$) effect over bark percentage of plants. Though cinnamon bark is the most important component in biological yield, there is still a possibility to enhance the productivity of cinnamon plants through the treatment combinations with optimum percentages of other plant parts.

Keywords: *Biological Yield, Cinnamon, Seedlings, Spatial Pattern, Vegetatively Propagated Plants*

Future Research Direction of Rooftop Agriculture in South and South East Asia: A Desk Review through Urban Sustainability Approach

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Humanity in 21st century deliberately evolves as urban species resulting pressing issue of food security during a time where available fertile land is minimal. Rooftop gardens are gaining relevance at such phase as they have the potential to meet the growing demand of nutritional needs in cities and enhance the ecosystem services along with the social capital. Yet, there is no adequate researches done and research literature available to understand how cities can achieve sustainability via urban rooftop agriculture. This study makes an attempt to assess the research capacities of rooftop gardening as a way of promoting rooftop agriculture. This research is primarily a systematic literature review of thirty selected articles from Science direct, Elsevier and Academia Education digital databases. Selected literature comprised of studies from Bangladesh, India and Nepal representing South Asia and Malaysia, Singapore and Vietnam representing South East Asia. According to the implications of our analysis, rooftop agriculture has mainly been studied under the field horticulture. Moreover, it has been researched as a typology of urban agriculture and its food production potential is acknowledged mostly. Scholarly research outputs are increasing from the last decade both quantitatively and qualitatively with multiple author contributions. The way forward promoting rooftop farming in cities need outreach programs, capacity development and policy interventions and nations must foster research partnerships, collaborations and investments. Moreover, it is essential to have a productive mechanism to disseminate the regional success stories and best practices among local urban community to transform their rooftops to more conducive communal spaces.

Keywords: *Future Research Direction, Rooftop Agriculture, South Asia, South East Asia, Urban Sustainability*

Livestock Production

Assessing Farmer Attitude on Dry-Cow Welfare in Selected Veterinary Divisions in Kandy District of Sri Lanka

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Dry cow management practices influence on health, welfare and improvement in milk production in the following lactation. Poor farmer–cow relationship and negative attitudes of the farmer on humane practices will reduce cow welfare and overall productivity. In this study, farmers' attitudes on key dry cow management practices and dry cow welfare were observed via an open structured questionnaire. A total of forty dairy farmers in Kandy district (veterinary divisions: Panvila (n=12), Pathadumbara (n=13), Kundasale (n=15)) were participated. Data were collected through face-to-face interviews. Collected data were statistically analyzed using SPSS version 23.0. The majority of the farmers were men (77.5%) in small-scale farming (herd size$<$10, 87.5%) with part-time involvement (72.5%). Most of the farmers belonged to 35-50 years (42.5%) of age with more than ten years of experience (62.5%). Farmers' attitudes about management practices were significantly affected by gender and part/full-time involvement. A decreasing probability of the effect of gender was observed for health (P=0.03) and calving management attitudes (P=0.02). Male farmers were better than females in welfare-friendly attitudes for the health and calving management attitudes. Farmers in part-time involvement in dairy also had a significant impact on welfare positive attitudes towards calving and health management practices (P=0.038 and P=0.013 respectively). Though the majority of farmers were not aware of the concept of dairy cow welfare (90%) they had positive attitudes on routine dry cow management practices (80%). However, considerable percentages of farmers (12.5%) were uncertain of welfare-friendly routine management practices and had answered as "Neither agree nor disagree". overall, majority of farmers had welfare positive attitudes towards routine management practices. We suggest proper education programs to improve welfare friendly attitudes of the farmers who were uncertain of the dry-cow welfare.

Keywords: *Dry Cow, Management Practices, Welfare*

Effect of Incandescent Bulbs Emitted Light Colours on Performance, Gathering Density and Behaviour of Broiler Chicks during Brooding Period

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Light influences health, behaviour, welfare and production of broilers. Performance during brooding period affects the future production. Objective of the study was to investigate how incandescent bulbs (60 Lux; 60W) emitted primary light colours [blue, green, red and white/ yellow normal light (Control)] affect the performance, gathering density (GD), mortality and behaviour of brooding chicks. Broiler chicks of strain Cobb-500 (n=144) were subjected to the experiment. Light colour (LC) treatments were replicated 6 times adopting completely randomized design. Brooder cages (n=24) were assigned with birds by balancing weights (40.87g±6). Feed intake (FI), water intake (WI), mortalitywere recorded daily. Weight gain (WG) was recorded weekly. Behaviour and GD were recorded daily covering three sessions; morning, evening and night. Common behaviours (18); lying, eating, drinking, standing, standing on feeders/drinkers, walking, wing/leg stretching, sleeping, wing flapping, feather pecking, vocalizing, running, litter eating, dozing, body shaking, bird interaction, excretion, other behaviours were examined for 14 days. Mean comparison was done using one way ANOVA. Walking was significantly affected ($p<0.05$) by LC where red treated chicks performed the highest walking and blue treated chicks showed the lowest. However, most of the behaviours were not significantly affected ($p>0.05$). Though WG was not significantly affected ($p>0.05$), maximum (515.42±7g bird^{-1}) and minimum (494.44±11g bird^{-1}) WG was recorded with blue and red LCs, respectively. Though Feed Conversion Ratio (FCR) was not significantly affected ($p>0.05$), the highest FCR was recorded in red (1.67±0) and the lowest was recorded in blue (1.51±0). Interaction (LC×Session) was significantly affected ($P<0.05$) the GD of chicks during first week. The highest GD was recorded in blue (64.46±4) while the lowest was recorded in yellow (49.04±4). It is concluded that the performance, mortality, WI, FI were not affected by brooding LC. As red exposed birds showed increased walking, feeder spaces can be expanded for red light brooded chicks while blue light brooding is more suitable for limited spaces as gathering is higher under blue.

Keywords: *Behaviour, Broiler Chicks, Brooding, Gathering Density, Performance*

Effect of Routine Management Practices on Welfare of Broiler Breeder Chicks and Growers: A Behaviour Assessment

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Some management practices which support growth have resulted various welfare issues in broiler breeder chickens in current commercial production systems which may lead to a lower productivity of the industry. Altered behaviors are the first biological response to stress or pain in animals. The present study assessed the normal behavior changes caused by identified management practices (debeaking by hot blade automatic electrical debeaking machine: 220V and 250W power, grading based on body weight and relocation, vaccination, sudden feed change from starter ration to grower ration) in broiler breeder chicks and growers. Cobb 500 fast feather broiler breeder chickens were randomly selected from a flock at the age of 4 days and the grower stage (at the age of 4 wks., 6 wks. and 9 wks.). Three replicates from each sex were arranged using 10 birds per each replicate for each age group. Behaviours were recorded before and after application of the management practices based on an ethogram. Two sample T-test was performed to find the treatment effect on behaviors. Generalized linear model was used to analyze the day effect on behaviors after applying the treatment to assess how long does the effect persist. Mean separation was done using Tukey–Kramer test. Gentle feather pecking was reduced ($P<0.05$) after debeaking in the chicks, and resting behavior of the chicks was increased ($P<0.05$) on the first day after debeaking. In overall, growers exhibited low frequencies for wing flapping, floor pecking, feeding and resting behaviors after grading and relocation ($P<0.05$). Object pecking was significantly decreased in growers after sudden feed changing and administrating vaccines. Wing flapping and feeding in growers were gradually increased ($P<0.05$) over the three consecutive days after vaccination indicating gradual reduction of pain. Overall, frequency of feeding and pecking were higher in cockerels ($P<0.05$). In conclusion, studied management practices altered some behaviors indicating reduced welfare of the chicks and growers. Thus, we suggest study of possible methods to minimize the observed bahaviour changes to enhance the welfare of chicks and growers enabling better productivity.

Keywords: *Behaviour, Management Practices, Pain, Stress, Welfare*

Implications of *Hermetia illucens* Larvae on Fish Histomorphology, Gut microbiota and Haematology: A Review

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Role of aquaculture in ensuring a sustainable protein supply could be bolstered by introducing dependable feed ingredients to reduce feed costs. By evaluating growth performance, histopathology, gut microbiota and haematology of various fish species, fish nutritionists have demonstrated *Hermetia illucens* as a potent protein source. However, a comprehensive review would be essential to gather existing knowledge on histopathological, gut microbial and haematological impacts of *H. illucens* on different fish species, for further improvements. Up to 100% incorporation of *H. illucens* larvae was evidenced in extremely diversified microbial populations. An increment in population sizes was exceptional for lactic acid bacteria and *Clostridium spp* among most fish species and, consequently, suppression of harmful microbial (Shewanellaceae, Enterobacteriaceae families) activities were observed. With the inclusion of *H. illucens* larvae, remarkably reduced plasma cholesterol levels were observed among most fish species. It was also revealed that the Haemoglobin content, Erythrocyte (RBC) count, Mean Corpuscular Volume (MCV), Packed Cell Volume (PCV), White Blood Cell (WBC) count, lymphocytes, monocytes and neutrophils like blood parameters were within the acceptable limits. Histological changes have not been reported in many cases even for the inclusion of 100% except for few findings. Studies with fish spp. Atlantic salmon, Jian carp, Zebra fish and etc. have shown the possibility of incorporating *H. illucens* larvae to the fish feed. However, mild intestinal inflammation was reported, in some fish spp with inclusion of *H. illucens* larvae to the feed. Chitin, a prominent compound in *H. ilucens* larvae, was identified as the possible reason behind the histopathological, gut microbial and haematological impacts.

Keywords: *Fish Feeds, Haematology, Histopathology, Microbiota, Protein Source*

Management Practices and Attitudes of Buy-Back Farmers towards Broiler Chicken Welfare; Gampaha District, Sri Lanka

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The buy-back system is well established in the current broiler chicken industry in Sri Lanka. Stockman's attitude always affects the welfare of poultry and management practices. This study assessed some key management practices and attitudes of the buy-back farmers towards broiler welfare. A total of forty poultry farmers engaged in buy-back system in Gampaha District, Sri Lanka were interviewed via telephone conversations using an open structured questionnaire. Relationships between variables were computed by Ordinal Logistic Regression. The majority of the farmers were male (82.1%), were at the age of 35-50 years (56.4%) and had more than 5 years of experience with buy-back system. The most popular flock sizes were 1000-5000 birds (64.1%). All farmers used open-sided houses. Overall, 94.5% of farmers isolate sick birds but no one euthanize severely injured/sick birds. Many farmers provide medication for the sick birds (71.8). More than half of the farmers were not aware of the concept of farm animal welfare (56.4%). Attitude on livestock welfare, transportation and slaughtering compared with gender, age, experience and education resulted in no significant differences. The majority of farmers were uncertain whether poultry should be free from fear (99%) and pain (94.8%), transport cause stress (89.7%), and stunning reduce pain (89.6%) or not. There was a trend to be significant (P=0.051) of welfare awareness (Yes) with the attitude of the way of handling is important. Many farmers stated that handling does not affect meat quality (82.4%) and does not cause pain and stress to birds (51.3%). When flock size increased, farmers awareness of the pain of birds is decreased (P=0.0001). Results revealed that the majority of buy-back farmers had negative or neutral attitudes towards poultry welfare, and management practices were mainly production oriented. We suggest poultry welfare awareness programs would enhance the positive attitude of the farmers, ensuring welfare of broiler chickens.

Keywords: *Attitude, Broiler Chickens, Buy-back Farmers, Welfare*

Potency of *Hermetia illucens* Linnaeus, 1758 Larvae to Replace Fishmeal in *Labeo rohita* Hamilton, 1822 Diets

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A 42-day feeding experiment was conducted to investigate the efficacy of different incorporation rates of black soldier fly larvae (BSFL) meal in the diets of *Labeo rohita* (Rohu) fry (Initial mean weight ± SE - 0.177 ± 0.0007 g). Four experimental diets with different levels of BSFL meal (0%, 25%, 50% and 75%) were prepared in iso-caloric (3100 kcal kg^{-1}), iso-nitrogenous (35%) and iso-lipidic (11%) manner. Fish were kept in a flow through system with a stocking density of 80 fish m^3. Fish were fed to meet their daily requirement and tanks were cleaned three times per week. Body weights and body lengths were measured in weekly manner and water quality parameters were recorded once in two weeks. *L. rohita* fry fed with 25% BSFL meal diet showed the significantly highest ($p<0.05$) body length gain (1.857 ± 0.014 cm), body weight gain (0.687 ± 0.001 g), specific growth rate (3.781 ± 0.006% day^{-1}) and protein efficiency ratio (1.467 ± 0.006). Feed conversion ratios of diets % (2.071 ± 0.009) and 25% (1.946 ± 0.008) were only within the acceptable range. Survival rates (85.3 ± 1.33 – 89.3 ± 1.76%) were consistent among each treatment. Water quality parameters were also remained within the general limits. Our study suggested that, 25% BSFL meal incorporated diet was the best demonstration for obtaining an optimum growth in *L. rohita* fry.

Keywords: *Fry, H. illucens, L. rohita, Fishmeal Replacer, Fish Feeds*

Prevalence of Footpad Dermatitis and Carcass Defects in Broiler Chickens Reared in Closed and Open-sided House Systems

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Footpad dermatitis is the occurrence of necrotic areas of the planter surface of the foot in birds. It is considered painful and causes reduced welfare in birds. Carcass defects occur due to various factors in farm level to the processing of the bird. This study assessed the prevalence of footpad dermatitis and carcass defects in broiler chickens reared in closed and open-sided housing systems. In total 155 birds (72-Closed, 83-Open-sided) were used for assessing footpad dermatitis. Severity of footpad lesions were assessed macroscopically using 0-3 scoring system. Both feet were scored and the mean score was used for the statistical analysis. Overall, 44 carcasses (16-Closed, 28-Open-sided) were assessed for carcass defects. Defects (blood spots, hemorrhages, broken bones, bone dislocations) were assessed in wings, breast, drumsticks and back of each carcass. Analysis of the scores was done using Mann Whitney U test using Minitab 19 software. Results showed that there was no significant difference ($P>0.05$) in prevalence of footpad dermatitis between the closed and open-sided housed birds. However, the prevalence of footpad dermatitis in chicken was considerably high (Closed -63.9%, Open-sided -83.2%). In overall, 18% of the birds reared in closed house had severe lesions (score 3) whereas it was 3.6% in the open-sided housed birds. There was a trend of higher number of open-sided house birds having blood spots in the wings ($P=0.05$). No significant differences ($P>0.05$) were observed for the other carcass defects in between the housing systems. More than 50% of birds had hemorrhages on the wings in closed (81.2%) and open-sided (71.4%) house systems. Closed housed birds had bone dislocations in the wings (12.5%). In conclusion, results revealed that high prevalence of footpad dermatitis and carcass defects in broiler chickens reared in closed or open-sided housing systems.

Keywords: *Broiler Chicken, Carcass Defects, Footpad Dermatitis, Poultry Housing System*

The First Ever Induced Breeding and Larval Rearing of Critically Endangered, Endemic Freshwater Fish *Labeo lankae*

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Many freshwater endemic fish species in Sri Lanka are listed as either endangered or critically endangered, showing the dire need of human intervention in their conservation. Captive breeding of these fish species may play a pivotal role as the first step of stock enhancement. Captive breeding efforts for critically endangered freshwater fish species in Sri Lanka are scanty and protocols are yet to be developed for many species. Present study was conducted to develop a protocol for induced breeding and nursing of hatchlings of critically endangered fish species Thambalaya (*Labeo lankae*). As the first-ever study, rearing *L. lankae* in captive conditions and breeding were conducted successfully. Induced breeding was performed by hormonal treatment for ovulation and spawning (sGNRHa + Domperidone) at the rate of 0.5 ml per kg for females and 0.2ml per kg for males. Breeding was performed in a hatchery jar and found that the latency period was 10 hrs. Selected females produced approximately 48000 eggs and they were spherical, non-sticky, and kept in hatchery jar and embryonic growth completed within 18-22 hrs. Eggs hatched at the water temperature of 27.4^0C, dissolved oxygen 8.1 mg/l, and pH at 7.4. Free swimming *Post larvae* were first fed with blended whole chicken egg and then with artemia nauplii, followed by daphnia and formulated powdered feed with 42% crude protein. In conclusion, this study records the first ever evidence of successful captive breeding and larval rearing of *L. lankae*.

Keywords: *Critically Endangered, GnRH, Induced Breeding, Labeo lankae, Post larvae*

Antimicrobial Resistance Profiles and Knowledge among General Public Regarding Antibiotics from a Rural Ecosystem in Sri Lanka

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Antimicrobial resistance (AMR) is a global health problem. In order to adequately address AMR, it is important to take integrated actions across human, animal and environmental health sectors. Reducing AMR by enhancing public awareness is one of the major goals of the World Health Organization. Identification of the extent of resistance through surveillance is another initiative. This study was designed to evaluate the knowledge and perception regarding antibiotics and AMR among the general public in a rural ecosystem. Furthermore, the AMR profiles in *Escherichia coli* (*E. coli*) isolated from wildlife, livestock and soil in the selected ecosystem was also evaluated. Wildlife was considered as the sentinels of environmental contamination. One square kilometer area in Dambana was selected for the study. An interviewer administrated questionnaire survey was conducted among general public (n=147) and analyzed. Soil and freshly voided faecal samples from livestock and wild animals were collected for isolation of *E. coli* and their sensitivity against 12 antimicrobials was tested using standard protocols. The highest resistance was for ampicillin among *E. coli*, showing 4.3% and 3.6% resistance in livestock and wildlife respectively. Highest intermediate resistance was observed for streptomycin and the percentages were 14.9% and 28.6% in livestock and wildlife respectively. An *E. coli* isolated from soil was resistant against Ampicillin and Imipenem. According to the findings of this study, AMR does not appear to be a considerable problem in the studied rural ecosystem. However, the general public showed poor awareness regarding antibiotics and AMR. Most of them identified Panadol as an antibiotic and 65% respondents did not know the effectiveness of antibiotics. This lack of awareness can lead to increased AMR development and transmission. Therefore, it is important to educate the general public regarding antimicrobial resistance and thereby prevent further development of AMR in said setting in Sri Lanka.

Keywords: *Antimicrobial Resistance, General Public Awareness, E. coli Rural Ecosystem, Sri Lanka*

Post-Harvest Processing, Storage and Technology

Development of an Edible Fruit & Vegetable Coating from Refined Rice Bran Wax

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Edible coatings are promising methods which extend the shelf life of fresh fruits and vegetables. Rice bran wax based coating also acts as an excellent shelf life extension approach. Rice bran wax which is a by-product of rice bran oil refining process can be utilized as an edible coating after purification. In this study, three purification methods named, A, B, C were carried out. Method-A; crude wax was refluxed for defatting with hexane and Isopropyl alcohol (IPA) in two steps, next bleached with 10% sodium borohydride. Method-B; Equivalent to method A but only IPA was used for defatting. Method-C; A single step process where the wax was refluxed with 99% ethanol. Characteristic of the refined waxes along with the purity were as follows, color lightened, melting point increased, moisture, free fatty acids, acid values and peroxide values decreased. Thereafter, edible coatings were formulated using refined waxes, Polysorbate-80 and distilled water at 5%, 10% and 15% concentrations for dipping tomatoes. The effect of the above coating on physiochemical properties (Physiological Weight Loss (PLW), Total soluble solids (TSS), Titratable Acidity (TA) and pH) of tomatoes was measured within 21 days at 28 0C. PLW of uncoated tomatoes indicated the highest weight loss. Then 10% coating of method B, indicated the best results of PLW, which reduced the weight loss. 15% coating, tomatoes spoiled more than others due to the blocking of the respiratory cells. Considering the methods and coatings combination, TSS values of 10% coating in A and B were increased lesser than C method. The TA of the tomatoes declined with maturity but their pH increased. All the physiochemical properties were significantly affected ($p<0.05$) for coating treatments. Finally, it could be suggested that 10% coating of all methods indicated the effectiveness of the physiochemical properties.

Keywords: *Edible Coating, Refining Process, Rice Bran Wax, Tomato*

Estimation of Total Polyphenol and Nitrogen Contents in Three Different Cultivars of Tea (*Camellia sinensis*) Grown in Matara District by Near-Infrared Technique

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When compared to other types of tea grown in Sri Lanka, low-grown teas have a distinct flavor, color, and aroma. The biochemical composition of the tea leaves determines these qualities. However, there is no reported study related to the variation of the chemical profile of most common tea cultivars grown in the low country region. Therefore, this study was conducted to determine the variation of polyphenol content and total N contents of commonly grown tea (*Camellia sinensis*) cultivars in Matara District, Sri Lanka. Further, Applicability of NIR technique as rapid method in total polyphenol and nitrogen content determination was one of the objectives of this study. Having followed stratified random sampling, 18 estates were selected from Matara District keeping three tea inspector divisions; Morawaka, Akurassa and Uuruboka as strata. Tea cultivars; TRI 2025, TRI 2026, and TRI 4042 were selected for this study. Fresh tea leaves from each variety grown in each selected estate were collected. Then fresh tea leaves were placed in an icebox and immediately transported to the laboratory. Then they were dried at 70 °C for 2 hours and packed in Al foils. Each sample was crushed and homogenized using a Burr Mill grinder. Powdered tea leaf samples were analyzed by using a NIR polyphenol analyzer (Model GTN-B) at 780-2500 nm wave length. For comparison, polyphenol contents of powdered tea samples were analyzed by Folin ciocalteu spectrophotometric method. Polyphenol content of cultivars; TRI 2025 (20.6 ± 0.32%) mm^{-1}, TRI 2026 (19.9 ± 0.32%) mm^{-1} and TRI 4042 (18.9 ± 0.28%) $mm^{-1}$and their Total N contents (4.8 ± 0.13%) mm^{-1}, (4.4 ± 0.07%) $mm^{-1}$and (3.9 ± 0.13%) mm^{-1} respectively were found be significantly different ($p<0.05$). The correlation coefficient in NIR and Folin methods was 0.82. Therefore, with further validation, the NIR technology may be employed as a rapid method to determine polyphenol content of tea leaf.

Keywords: *Polyphenol, Total N, Low- grown Teas, Near-infrared; Folin Ciocalteu*

Evaluation of Physicochemical Properties of Tomato varieties Grown in Uva Region, Sri Lanka and their Suitability for Value Addition

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Value addition is a viable solution to manage surplus and postharvest losses. Suitability of tomato varieties is one of the critical problems in value addition. Physicochemical properties are important indicators which are used to detect suitability of a tomato variety for value addition. Aim of the study was to evaluate physicochemical properties of new eight tomato varieties for their suitability for value addition. Furthermore, physicochemical properties of heat treated (90°C for 5 minutes) tomato pulps were evaluated during 10 weeks of storage period under refrigerated condition (4°C). Tomato varieties named as T_1, T_2, T_3, T_4, T_5, T_6, T_7 and T_8 were obtained with the assistance of Provincial Department of Agriculture, Uva Province. Data were analyzed using ANOVA test by Minitab 17 software. Complete Randomized Design (CRD) was used as experimental design. Important physicochemical properties for value addition such as total soluble solid (TSS) content, pH value, lycopene content and pulp color (δE value based on L*, a*, b* in Hunter colour scale) were determined. The antioxidant activity was determined by using 2-2-Diphenyl-1-1-picrylhydrazyl (DPPH) radical scavenging activity. The variety T_7 showed the highest TSS content (4.60 ± 0.1°Brix). The T_1 variety showed the highest antioxidant activity (75.21±1.15 inhibition%) and the highest lycopene content (175.84 ± 0.34 mg kg^{-1}) in the fresh pulp. The highest pH value (4.61 ± 0.01) was found in T_7 variety. Moreover, the highest δE value was observed in T_2 variety (18.7 ± 1.11). After the heat treatment, values of physicochemical properties were increased. In all the samples lycopene content, antioxidant activity and TSS content were decreased and pH values were slightly increased during storage time ($P<0.05$). T_1 variety was selected as most suitable tomato variety for value addition with considering desirable physicochemical characteristics.

Keywords: *Antioxidant Activity, Lycopene Content, Physicochemical Properties, Tomato Varieties, Value Addition*

Evaluation of Powder Properties of Hot-air Dried Bael Fruit (*Aegle marmelos*) Powder

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Bael (*Aegle marmelos*) fruit is an important tropical fruit that has various nutritional and therapeutic properties. Although bael fruits have these valuable properties, it is considered as an underutilized fruit species in Sri Lanka and therefore postharvest losses are high. Drying is a suitable alternative for the postharvest management of bael fruit. Therefore, the aim of the present study is to obtain three different types of bael fruit powders by drying pulp of matured fruits at 60^0C, 70^0C and 80^0C temperatures. After obtaining dried powders, moisture content, pH, rehydration properties, colour analysis, density, flowability characteristics were determined. Sorption isotherm was developed by obtaining data at different relative humidity conditions. According to the results, all fruit powder samples had desirable moisture contents ($<$10%). Lowest pH value was obtained in powder dried at 70^0C (4.84±0.04).According to the rehydration properties, better solubility characteristics were observed in sample dried at 60^0C (86.08% ± 0.99) and 70^0C (83.76% ± 0.11). Considering all the chroma analysis values, most desirable characteristics were shown in sample dried at 60^0C (L^* = 58.32 ± 0.32, a^* = 13.03 ± 0.30, b^* = 25.45 ± 0.10) with a pleasant aroma. Highest bulk density (520.96 ± 0.95kg m^{*-3}) was observed in sample dried at 60^0C and it is desirable for low cost packaging and transportation. Sample dried at 60^0C showed very good flowability and cohesiveness properties according to the Carr index (12.5) and Hausner ratio (1.14). Bael fruit powder showed type III isotherm which is a characteristic for foods with high sugar contents. Considering all the evaluated characteristics, it can be concluded that hot air drying is a suitable method for preserving bael fruit and effective temperature for drying is 60^0C.

Keywords: *Bael Fruit, Hot Air Drying, Powder Properties, Temperature*

Extension of Shelf Life of Fresh Mushroom (*Pleurotus ostreatus*) Using Gamma Irradiation and Determination of Physicochemical and Microbiological Parameters Associated

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Mushrooms (*Pleurotus ostreatus*) have a growing demand in the local and export market owing to it used for food and medicinal properties. Fresh mushrooms have a short shelf-life (1-2 days) due to rapid post-harvest changes. This study was focused to extend the shelf life of fresh mushrooms using gamma irradiation and investigate the changes of physicochemical and microbiological parameters with gamma irradiation at different dosages. Mushroom samples were collected from a particular farm in Western province Sri Lanka. Samples were irradiated at five different doses (0, 1, 2, 3, and 5 kGy) by using an industrial Co-60 gamma irradiator. Under physical parameters, moisture content, water activity, weight loss, texture, and color intensity were measured in each treatment. Browning index was measured as a chemical parameter. Microbial quality was determined by using the total plate count method. All treatments were replicated three times. The physical appearance of irradiated samples was becoming unacceptable after 6 days of storage at room temperature. There was no significant difference ($p>0.05$) in all physical parameters of irradiated samples compared to the control sample at the initial day of storage. On the 6^{th} day mean values of all the physical parameters were significantly different ($p<0.05$) with the control sample. The average browning index of the control sample was 0.392±0.004 and for the 2 kGy samples it was 0.217±0.003 nm respectively on the last day. In Total Plate Count of irradiated samples showed a significant reduction in a dose-dependent manner and there was an increment of microbial count in all doses with the storage period. Accordingly, the results conclude that the shelf life of fresh mushrooms can be extended up to 6 days with a minimum dose of 2 kGy conserving quality parameters.

Keywords: *Dose, Gamma Irradiation, Mushroom, Shelf Life, Quality Changes*

Extraction of Natural Flavor from Mango (*Mangifera indica L.*) for Food Applications

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Processed food products with natural mango flavor are rarely present in the market and they are with high cost as mango is a perishable and seasonal fruit. This study was carried out with the objective of extraction of natural flavor from mango using a commercially applicable method. Based on preliminary studies, shaker extraction was selected as the best extraction technique while Tom EJC mango was selected as the best variety among the tested mango varieties. Samples were prepared using 40% (v/v) ethanol and water as solvent systems by using 1:5 solute: solvent ratio and were extracted using shaker technique for 24 hours. Sensory evaluation conducted for two flavor extractions have indicated that organoleptic properties were higher in mango flavor extracted using 40% (v/v) ethanol. This liquid form flavor was with pH value 5.04, total soluble solids 10ºBx, titratable acidity 0.59±0.03% and 108.27±2.8 g/L of alcohol. The best flavor extraction selected from sensory analysis was used to develop mango flavored stirred yoghurts with four different levels; 5%, 7.5%, 10%, 12.5% and another plain yoghurt was prepared without adding flavor. pH, total soluble solids, titratable acidity, syneresis, viscosity and color exhibited a significant difference among each flavored yoghurt. Grouping using Tukey pairwise comparison and considering the properties with plain yoghurt have indicated that 12.5% was the most preferable level from the tested levels for mango flavored yoghurt production. At this level most of the physicochemical properties were similar to plain yoghurt while maintaining mango flavor and exceeding that level was not cost effective. Accordingly, mango flavor extraction using low fiber variety with characteristic flavor like Tom EJC mango with shaker technique using 40% ethanol can be recommended to extract natural flavor more efficiently for commercial applications.

Keywords: *Extraction Techniques, Food Applications, Mango Flavor*

Applied Science Approaches for Combating Global Challenges

The challenges we face are massive, urgent, and interconnected. We need people across all sectors to pull together and move us to a bright and strong future. Scientific problems unsolved with existing knowledge or through traditional approaches can be found in all disciplines. Fortunately, the rapid growth of research capabilities around the world strengthens the search for solutions to global challenges. Submissions based on the research leading to solve global issues in the areas namely Natural and Conservation Sciences, Food Science and Technology and Chemical & Physical Sciences and Technology are enclosed within this section.

Plenary Speech by Professor Balachandran Jayadevan

Development of Non-aqueous Solution Technique for the Designed Synthesis of Functional Bimetallic Nanostructures

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Several techniques have been developed to synthesize metallic and alloy nanoparticles (NPs) to utilize their novel properties at the nanoscale. Consequently, the development of bimetallic nanoparticles with functional properties has been attempted extensively using the above techniques but with limited success in controlling the morphology and structural properties. The reason was the inability to control the kinetics of the reduction reaction in most liquid-phase syntheses, even in the non-aqueous polyol reduction technique. However, the authors have found that the alcohol reduction technique, which possesses mild reducing conditions, has the potential of controlling the reduction reaction incorporating other phenomena such as diffusion, etching, and galvanic replacement during nanostructure synthesis [1-3].

In this talk, the theoretical investigation of the reduction potential of straight-chain alcohols using molecular orbital calculations and the experimental verification of the theoretical findings by reducing transition metals in alcohols will also be presented. Then, the formation mechanism of metallic particles in the metal-alcohol system and their successful implementation to synthesize bimetallic nanostructures (coreshell, wire, and tube) via the incorporation of diffusion and etching, besides the reduction reaction, will be introduced [4].

The control over the reducing power is proved conceivable by varying the alcohol type, complexing agent, and metal salts. Confirmation of the successful synthesis of bimetallic nanostructures via the control of the reduction kinetics using the alcohol reduction method will also be demonstrated using Cu-Co as a bimetallic model system [5]. The synthesis of CuCo nanostructures such as CuCo coreshell (size ranged between 40 and 15 nm) and hollow alloy nanoparticles and nanotubes by incorporating diffusion and etching phenomena during the reduction reaction will be introduced. The diffusion of the Cu core in the formation of a CuCo alloy hollow nanostructure into the Co shell by controlling the reduction time gap between Cu and Co and the crystal structure besides the reduction sequences will be demonstrated using time-resolved sampling.

The proposed technique has proved the possibility of obtaining high-temperature bimetallic phases via nanoscale synthesis. The novel synthesis strategy presented can be used to develop functional bimetallic nanostructures composed of transition and noble metals.

Keywords: *Alcohol Reduction Technique, Bimetallic Nanostructures, Transition Metals, Non-Aqueous Technique, Diffusion, Etching*

References

[1] Nagao, A. et al., Nanoscale 2015, 7, 9927-9934.
[2] Taniguchi, K. et al., SN Appl. Sci. 2019, 1, 124.
[3] Katagiri, M, et al., J.. ACS Appl. Nano Mater. 2020, 3, 418427.
[4] Ishijima, M. et al., Inorg. Chem. 2021, 60, 94329441.
[5] Ishijima, M. et al., Inorg. Chem. 2021, 60, 1443614445

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Food Science and Technology

Biofilms of *Salmonella*, *E. coli*, *Proteus* and Their Combinations; A Time Scale Investigation

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Bacterial biofilms are self-produced matrix of extracellular polymeric substances which provides protection against unfavourable conditions. Biofilm formation is affected by several factors such as time, temperature and humidity etc. This study investigated the biofilm forming ability of *Salmonella*, *E. coli* and *Proteus* spp. isolated from chicken meat when they are present as mono species and in combinations as a time series analysis. Fifty broiler chicken meat samples collected from retailer shops for a period of 6months from December 2019 were used for the isolation of organisms, which were allowed to grow for different time durations (24hr, 48hr, 72hr, 96hr and 120hr). Biofilm forming ability was determined by microtiter plate assay and they were classified in to different groups as weak, moderate, strong biofilm formers. This study revealed that majority of the organisms developed strong biofilms: *Salmonella* alone, *Proteus* together with *E. coli* and *Proteus* together with *Salmonella* and *Salmonella* together with *E. coli* at 48 hours. *Salmonella* and *E. coli* together showed moderate biofilm forming ability at 24, 72, 96 and 120hrs. *Salmonella* and *Proteus* together form moderate biofilm at 24hrs and strong biofilm at 48hrs and remained for 72hrs. *Proteus* together with *E. coli* showed moderate biofilm forming ability at 24, 72 and 96hrs whereas at 48 and 120hrs they were strong biofilm formers. When *Salmonella* was alone as a mono species at 24hrs it showed weak biofilm forming ability whereas they reached to strong biofilm levels at 48hrs. *E. coli* started the biofilm formation little later than the other organisms checked, it reached to the weak biofilm states at 72hrs and it remains as it is at 96hrs as well, at 120hrs it produces moderate biofilm. *Proteus* showed moderate biofilm from the beginning of quantification and it showed the capacity of forming biofilm even before 24hrs and it remained at 48hrs also as moderate. Strong biofilm by Proteus was at 72hrs and at 96hrs it was moderate. All the mono and dual species biofilms remained as strong at 120hrs except for *Salmonella*, *E.coli* combination and *E. coli* alone, where they remained as moderate biofilms. This study concluded that biofilm forming ability of *E. coli*, *Proteus*, *Salmonella* and their combinations varied with time. Majority of them have the capability of having strong biofilms at 48hrs, whereas some at 72hrs. Some organisms have delayed response in forming biofilms.Findings of this study will pave a way towards developing some biofilm eliminating methods in the future based on the characteristics of different biofilms.

Keywords: *Biofilm, E. coli, Proteus, Salmonella, Time Scale*

Development and Characterization of *Ulva fasciata* Incorporated Pie Crust

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Seaweeds are underutilized abundant natural resources in Sri Lanka due to the lack of (a) awareness of the value of seaweed consumption and (b) availability of seaweed based food products, that match with Sri Lankan taste. The aim of present study was to develop a novel *Ulva fasciata* incorporated pie crust as an opportunity to incorporate seaweeds in conventional food products in Sri Lanka. *Ulva fasciata* seaweeds were manually collected in January, 2021 from Matara, Sri Lanka. The pie crust was developed with 20% of *Ulva fasciata* seaweed powder, wheat flour, shortening and water, together with a control with 0% seaweed powder. Results of proximate composition and element analysis of the seaweed powder, seaweed incorporated pie crusts and the control revealed the following results. Moisture, fat, carbohydrate and ash %of the new crust were revealed respectively as 10.459 ± 0.013, 12.619± 0.311, 42.829 ± 0.007 and 3.711 ± 0.056. The new 20% *Ulva fasciata* incorporated pie crust had significantly high ($p<0.05$) protein content (10.212% ± 0.163) and fiber content (20.077% ± 0.332) compared with those (respectively 5.741% ± 0.232 and 5.264% ± 0.421) for the control. Both dried *Ulva fasciata* powder and *Ulva fasciata* incorporated pie crust has Ca as the dominant mineral. *Ulva fasciata* incorporated crust was organoleptically better than the normal crust (control), since the seaweed has the ability to enhance the umami flavor. Our results also indicate that incorporation of *Ulva fasciata* has positively influenced fibre and protein content of the pie crust.

Keywords: *Pie Crust, Proximate Composition, Seaweed, Ulva fasciata*

Development of Dragon Fruit (*Hylocereus polyrhizus*) Incorporated Novel Set Yoghurt

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Dragon fruit (*Hylocereus polyrhizus*) is a commercialized fruit grown in Sri Lanka with promising antioxidant properties. In this backdrop, well ripen dragon fruits were used to develop fruits incorporated set yoghurt. The pasteurized fruit pulp was added at the levels of 7.5, 10, 12.5 and 15% w/v with the selected levels of sugar and gelatin. Product accepted from sensory evaluation, was tested against the control (without added fruit) yoghurt for physicochemical, phytochemical and microbial analysis. Results showed that 10% sugar, 0.8% gelatin and 7.5% dragon fruit pulp were the best combination for fruit incorporated yoghurt according to the sensory analysis ($p<0.05$). Addition of dragon fruit significantly increased ($p<0.05$) the total phenolic content (3.57±0.04 mg GAE $100g^{-1}$), total monomeric anthocyanin (1.47±0.45 mg L^{-1}) and antioxidant activity (Ferric reducing antioxidant power assay: 0.186±0.00 µ mol Fe^{+2} $100g^{-1}$: IC_{50}:219.19±1.58 ppm) of fruit incorporated yoghurt compared to that of control yoghurt. During 18-days of storage period at refrigerated condition (<5 ^{0}C), acidity of all samples increased (<0.05), while p^H decreased (<0.05). Syneresis increased (<0.05) with the storage period in control while fruit yoghurt exhibited the decreasing pattern with the time. Viscosity and water holding capacity of all samples increased (<0.05) with the time. Yeast and mould count did not exceed the Sri Lankan Standard Institute (SLSI) recommendations (1000) during the 15-days of storage. *Staphylococci spp* and *Escherichia coli* was not detected throughout the storage. In conclusion, 10% sugar, 0.8% gelatin and 7.5% dragon fruit pulp were the best levels for dragon fruit incorporated yoghurt productions which have 15 days of shelf life at refrigerated conditions with promising antioxidant properties.

Keywords: *Antioxidants, Hylocereus polyrhizus, Total Phenol, Yoghurt*

Evaluation of the Effect of UV treatment on Shelf Life and Physicochemical Properties of Coconut Water as an Alternative to Thermal Pasteurization

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Coconut (*Cocos nucifera L.*) is an important tropical crop and coconut water has a unique chemical composition. Coconut water loses its delicate flavor and important nutrients when heated during commercial processing. Therefore, this study was conducted to identify the effectiveness of ultraviolet treatment to prolong the shelf-life of coconut water and to compare ultraviolet and thermal pasteurization (85^0C for 10 min) on the sensory and physicochemical properties of coconut water.Coconut water taken from fresh coconuts was subjected to UV dose of 33 kJL^{-1} using the lab-scale UV pasteurization unit equipped with UV-C germicidal lamp (253.7nm). Brix, p^H,and titratable acidity of fresh, UV and heat pasteurized coconut water were measured at the beginning and throughout refrigerated storage (4^0C for 4weeks). The flavor profiles of coconut water samples were analyzed using solid phase micro extraction method. Vitamin-C content was analyzed using direct titration with iodine and sensory quality is evaluated using semi-trained assessors. The results showed that the ultraviolet treatment did not significantly change the p^H of 5.72, brix of 4.87 and the titratable acidity of 0.08% of the fresh coconut water sample. Ascorbic acid loss in heat and UV treated samples were 57.06% and 25.29% respectively. The UV treated coconut water product was microbiologically safe within 3 weeks of storage period at 4^0C temperature. Flavor profiles showed higher volatile flavor retention in UV treated sample than heat treated sample. Sensory panel showed that UV treated sample was liked as much as fresh sample, whereas heat pasteurized sample was significantly less liked. This study showed that the quality of UV treated sample was better than heat pasteurized coconut water sample.

Keywords: *Coconut Water; Flavor Analysis; Heat Treatment; UV Treatment*

Food Tourism to Aid Sri Lankan Economy after Covid-19: An Assessment on the Gastronomic Satisfaction of Young Adult Tourists

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Since the COVID-19 pandemic has severely hit the tourism industry, the industry has to switch to different strategies, in other words, the country should rethink and develop its approach to a more sustainable industry using alternative types of tourism. Undoubtedly, there is a huge potential for traditional, ayurvedic and diversified Sri Lankan food culture to be used as an added dimension in the tourism experience. Using the results of an online questionnaire survey, this study analyzes and assesses the relationships between the levels of gastronomy satisfaction of a convenient young adult tourist sample of 63 and reveals the opportunities, gaps, positive and negative impacts within the current industry. The majority (65.1%) of respondents had similar experiences of what they were expecting with foods before they come to Sri Lanka, while a small yet substantial 4.2% felt short. The findings indicate a strong positive relationship between overall gastronomy satisfaction and likelihood of recommending the Sri Lankan food experience to a friend (Kendall's tau b = .730, Spearman's rho = .816). From an array of different variables, these satisfaction scores were primarily dependent upon tourist's length of stay ($p = 0.017$) and spending on the foods per person per day. This amount of spending was significantly interrelated with the respondent's occupation ($p = 0.044$), region ($p = 0.003$), and whether it was a packaged tour or not ($p = 0.002$). Correlation matrices elaborate how the overall quality of food outlets is mostly impacted by two characteristics: cleanliness, personal hygiene and sanitation facilities ($r=0.642$); customer service and staff's professionalism ($r=0.641$). These findings were further reinforced using a triangulated multiple method, by assessing the experiences and knowledge of a few selected industry professionals and analyzing the perspectives of Sri Lankan travellers who have travelled outside the country. Community-based traditional food villages, more culinary-focused local and international promotions emphasizing the wide range of unique and authentic produce are the key suggestions of this study to revitalize the industry.

Keywords: *Alternative Tourism, Covid-19, Gastronomy Satisfaction, Sri Lankan Tourism, Young Adult Tourists*

Chemical and Physical Sciences and Technology

Adsorption of Heavy Metals on Na-Montmorillonite: Effect of pH and Adsorbent Dosage

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The rapid increment in world population, urbanization, industrialization, agricultural and household activities have caused water contamination by heavy metals, which is a significant threat to the well-being of life forms and environmental stability. To resolve this matter, cost-effective adsorbents have been studied including, Na-montmorillonite, to remove heavy metal contaminants from wastewater. Na-montmorillonite [$(Na,Ca)_{0.33}(Al,Mg)_2Si_4O_{10}(OH)_2 \cdot nH_2O$] is a porous 2:1 layered smectite clay bearing permanent negative charges caused by isomorphic substitution. Adsorption is an effective technique of wastewater remediation involving cation exchange and surface complexation mechanisms. In this study, the structure of the commercial Na-montmorillonite sample was confirmed by Powder X-Ray Diffraction analysis. Subsequently, the adsorption of Cu^{2+}, Ni^{2+}, Cd^{2+}, Cr^{3+}, Pb^{2+} heavy metal ions on Na-montmorillonite (the adsorbent) were studied in triplicate using single-element solutions in trace concentrations (100 mg L^{-1}), under ambient conditions. In addition, the adsorption behaviour of the most efficient heavy metal cation was evaluated as a function of the initial p^H (1-5) and adsorbent dosage (0.025-0.300) g. The results reveal that the adsorption efficiency on Na-montmorillonite increases as: Pb^{2+} (21.90%) $<$ Cd^{2+} (35.47%) $<$ Ni^{2+} (41.44%) $<$ Cu^{2+} (46.69%) $<$ Cr^{3+} (59.12%). This observation is in accordance with the characteristics of heavy metal cations (such as valency, size/ ionic radius). This study found that the adsorption efficiency of Cr^{3+} increased with rising pH and adsorbent dosage, whereas the adsorption capacity reduced with the increase of dosage. Optimum p^H and adsorbent dosage for Cr^{3+} adsorption were obtained as p^H 5 and 5 g L^{-1}, respectively. The remaining optimizations of the initial Cr^{3+} concentration and shaking time will be completed in the future, along with isotherm and kinetic studies. Eventually, an industrial wastewater sample is expected to be analyzed. Based on the results obtained and economic aspects, Na-montmorillonite can potentially be used as an efficient adsorbent for Cr^{3+} in aqueous wastewater systems.

Keywords: *Na-montmorillonite, Cr^{3+} ion, Heavy Metal Removal, Smectite Clay, Wastewater Treatment*

Comparison of Dropping Points of Conventional Grease against Modified Grease with Graphite

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Graphite is a naturally occurring form of crystalline carbon found in metamorphic and igneous rocks. The layered structure of graphite is being used as a lubricant in many applications. This study focuses on improving the quality considering the effects on dropping point of grease with the addition of graphite which is a vital component as it can introduce different properties to conventional grease such as ability to withstand high temperatures. Preparation of graphite grease was done by crushing graphite into a size less than 75 μm, and graphite percentages of 5%, 15%, 25%, 35%, and 45% by weight of grease was added and mixed with the developed grease. Five percent of natural latex as alocalizing agent was used by weight of graphite at each sample. Graphite-grease samples were prepared at a large scale. Dropping Point is one of the most important test methods available to assess the performance of grease to provide quality assurance during batch-to-batch manufacturing. As the temperature increases in test apparatus, drop of grease sample fall from the cup to the bottom of test tube and temperatures are recorded which confirm the ASTM D 2265. This temperature is the upper temperature limit to consider as the Drop Point for the grease but not the melting point. When graphite grease and conventional grease were tested, with the increase of graphite content in each sample, dropping point was observed to increase reaching 206^0C at sample containing graphite of 45% whilst reaching 173^0C for conventional grease. However it is found that introducing graphite beyond 50% affects adversely on other properties.Therefore based on the dropping point results, it is concluded that graphite-grease could be applied for high temperature applications. It is expected to conduct tests for further characterization. Therefore developed graphite-grease could be used in specific lubricant applications.

Keywords: *Dropping Point, Graphite, Graphite- Grease, Lubricants*

Development of PVP Based Electrolytes and Their Applications in Electrochromic Devices

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Electrochromism is a rapidly developing branch in applied material sciences due to their potential applications such as smart glass and display devices with low power consumption. Development and characterization of a Polyvinylpyrrolidone (PVP) based electrolytes and their applications in electrochromism were main aims of the present study. Several experimental methodologies such as AC impedance spectroscopy, Fourier transform infrared (FT-IR) spectroscopy, UV-Vis spectroscopyand cyclic voltammetry were used to optimize and characterize the electrolyte and the titanium dioxide (TiO_2) based electrochromic device.Set of liquid electrolyte samples were prepared by dissolving LiCl salt in Ethylene Glycol (EG). The molar ratio of total oxygen of ethylene glycol to lithium ions of LiCl ($O:Li^+$) was varied from 5:1 to 60:1. The best ionic conductivity of 1.276×10^{-2} S cm^{-1} was obtained at room temperature for the liquid electrolyte sample with molar ratio of $O:Li^+$= 15:1. Gel polymer electrolyte (GPE) prepared by adding 130 wt.% of PVP into the optimized liquid electrolyte showed ionic conductivity of 5.58 x 10^{-4} S cm^{-1} at room temperature.Remarkable electrochromic properties of TiO_2/FTO film with a persistent color change from blue colour to bleach state and bleach state to blue colour have been observed.Optical modulation of 59.9% at 700 nm and switching speed of $t_{bleaching}$=14.0 s and $t_{coloring}$=26.0 s were observed for electrochromic devices with the configuration of FTO/TiO_2/GPE/FTO.Long term stability of the polymer gel electrolyte dropped due to the hydrophilic property of PVP and stable nitrogen and oxygen bonds with lithium ions.

Keywords: *Electrolyte, Electrochromic Device, Optical Modulation, Ionic Conductivity*

Fabrication of Polydimethylsiloxane Using Atmospheric Pressure Plasma Jet:An Alternative Approach to Low pressure plasma Fabrication

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Bio-compatible devices generally go through a surface modification using low-pressure plasma devices to assist the biological applications. Plasma patternings from these devices come with a mask to achieve the desired pattern sizes.However,use of low-pressure plasma devices limits varying the pattern sizes as it depends on mask sizes as well as inability in quick removal of the fabricated materials from the source. To overcome these limitations, this study considered using an atmospheric pressure plasma jet (APPJ) as an alternate approach. This approach is low-cost and easy to assemble compared to low-pressure plasma technique. Plasma patternings were carried out on polydimethylsiloxane (PDMS) surfaces using Heliumgas APPJ with and without masks. APPJ fabricated PDMS surfaces with masks show pattern sizes of mask size irrespective of the irradiation time. As for the mask free condition, an increase in plasma patterning sizes was observed on PDMS surfaces with an increase in irradiation time. In addition, using a mask with set of holes in vicinity areas shows strong fabrication on APPJ focused central hole along with weak fabrication on surrounded holes. With these results, this study concludes that plasma patterning was successfully achieved through APPJ technique. Increase in low-irradiation time affects to increase the area of fabrication on PDMS surfaces for mask free patterning before it saturates with further increase in time. Also, it is expected that diffusion of excited and charge particles from the APPJ on PDMS surface for mask with set of holes is the reason for strong fabrication on central hole along with weak fabrication on nearby holes.

Keywords: *Atmospheric Pressure Plasma Jet, Polydimethylsiloxane, Plasma Patterning*

Identification of Residues of Kerosene in Fire Debris Evidence in the Presence of Poly Vinyl Chloride Interfering Compounds In an Arson Investigation

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Forensic science, in its broadest sense, refers to the application of different scientific disciplines to subjects which may have legal implications. In this context, the use of forensic science to investigate fires and fire-related crimes really covers all evidences of the investigation of the cause and origin of the fire scene. The study involves the results of the analysis of poly vinyl chloride (PVC) based household products without burning and burning under various tests conditions such as pyrolysis, with and without spiked kerosene for the purpose of identifying potential interfering compound in kerosene accelerate fires. Volatile compounds, in poly vinyl chloride (PVC) with and without burning were solvent extracted using passive headspace adsorption by charcoal strips followed by acetone. This assessment was carried out by gas chromatography/-mass spectrometry (GC/MS), and the data evaluation was done by extracted ion profiling (EIP) and target compound analysis. Data interpretation was found to be more complicated if fire debris samples include PVC based products in kerosene accelerated fires because PVC interfering compounds resemble as target compounds of C11-C16 alkanes in kerosene with a Gaussian pattern. PVC can produce both n-alkanes and aromatics depending on the temperature of the fire and cause pattern distortions making interpretation more difficult and might be mistakenly interpreted as both false-negative by masking alkane peaks and false-positive as kerosene. Nevertheless, PVC interfering compounds did not elute aromatics as in kerosene. Hence, these important key features, consecutive C3 aromatics (castle group) and target kerosene compounds could be considered to resolve this misinterpretation since kerosene in Sri Lanka contains aromatics in addition to alkanes relatively with a low abundance when it comes from the refinery.

Keywords: *Arson, Castle Group, GC-MS, Interferences, Pyrolysis*

Natural Sciences and Environmental Conservation

Assessment of Marine Water Quality for Recreation and Bathing Purposes in Charty Beach, Jaffna, Sri Lanka.

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Assessment of marine water quality parameters is an essential step to identify the ongoing issues in the beach, which can affect the ecosystem and the safety of the users. The present study was carried out for five months from December 2020 to April 2021 at Charty beach, Jaffna, Sri Lanka. The physical parameters were measured on-site using smarTROLL multiparameter (Insitu 458389), and a five-tube MPN test for microbiological analysis was carried out. The average temperature (29.24^0C), pH (8.18), turbidity (8 NTU), and dissolved oxygen (6.7 mg L^{-1}) were all found to be within the international marine water quality standards for recreational sites. The measured average nitrate (2.66 mg L^{-1}) and phosphate value (0.15 mg L^{-1}) exceeded the maximum values of international marine water quality standards. The highest nitrate and phosphate values were recorded during December 2020 which is in the year's rainy season. This may occur because of the surface runoff containing fertilizers and detergents due to the rainfall. Total coliform (34.85 MPN100 mL^{-1}) and E. coli count (2.64 MPN100 mL^{-1}) have lied within the threshold limits of WHO and international marine water quality standards for recreational sites. The highest total coliform count was also recorded during December 2020. It could be the result of rain-induced faecal contamination caused by surface runoff containing domestic and animal faeces. The total coliform and *E. coli* counts exhibited a strong correlation (γ=0.91 and γ=0.89, respectively) with rainfall data. So, based on the overall results of the marine water quality parameters, Charty beach can be considered a beach appropriate for recreational and bathing activities. Although the variation of the microbial parameters with time can cause an impact on the safety of the users,frequent and long-term monitoring with the evaluation of trophic index, water pollution index and planktonic analysis are recommended. .

Keywords: *Charty Beach, Faecal Pollution, Marine Water Quality, Recreational Waters, Water Pollution*

Biodegradation of Lignocellulose by Microbial Biofilms Developed From White Rot Fungi and Soil Bacteria

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Cellulolytic microorganisms are responsible for much of the cellulose degradation in soils. Although a variety of microorganisms i.e. white-rot fungi (WRF) are capable of degrading cellulose, only a few of them produce significant quantities of enzyme fractions which hydrolyse cellulose into simple sugars. Biofilms for hydrolysing lignocellulosic biomass have been reported in several studies. However, when compared to monocultures, their efficiency is lower, but no one has used WRF to develop biofilms. Thus, this study was focused on evaluating the efficiency of cellulolytic activity of mono and mixed microbial cultures. Microbial isolations were carried out using coir retting water and soil samples and were inoculated on Congo Red Agar with Carboxy Methyl Cellulose to screen the most effective cellulolytic WRF and bacteria. Fungal-bacterial biofilms (FBB) were developed from the selected microorganisms. The efficiency of cellulolytic activity of the selected FBB was evaluated using the production of reducing sugar through the Anthrone method. Two WRF (F3 and F4) and three bacterial isolates (B3, B4, and B6) were selected as the best cellulolytic microorganisms. Out of that, F4 and B3 showed the significantly highest cellulolytic activities ($P < 0.05$). All the biofilm combinations showed significantly higher sugar yield than that of the other monocultures. The highest mean sugar level (1823.90 ppm) and the highest sugar formation rate were observed in biofilm combination FBB2, with one WRF and two cellulolytic bacteria, after eight days of incubation. Thus, the selected FBB combination can be used to enhance the hydrolysis efficiency of cellulose for different industrial applications.

Keywords: *Carboxy Methyl Cellulose, Cellulose, Cellulolytic Activity, Reducing Sugar*

Population Dynamics of Sambar Deer (*Rusa unicolor unicolor*) in Horton Plains National Park, Sri Lanka

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We investigated the social organization of Sambar deer (*Rusa unicolor unicolor*) in Horton Plains National Park, Sri Lanka (HPNP). We used the antler stage of males and the behavior of individuals to describe the population's reproductive stages. Distance sampling protocols were conducted along road strip transects within the grassland area of HPNP (9.4 Km^2), each month over three years from 2018 to 2020. Population estimates varied over the seasons but the peak numbers were consistent from year to year with the highest number of individuals recorded in November-December (2002 ± 238.6 SE in 2018, 1766 ± 267.98 SE in 2019, and 1690 ± 299.42 SE in 2020), while the lowest numbers of individuals were recorded in May- June (513 ± 61.702 SE in 2018, 407 ± 49.68 SE in 2019, and 347 ± 51.76 SE in 2020). The percentage of antler-cast males peaked in March-April of each year, while the highest percentage of males in hard antler was observed in November through January. Females were observed with newborn calves throughout the year but the highest number of newborn calves was recorded in July-August of the year (a range of 210-267 calves observed at peak). Mean group size was variable throughout each year with the largest groups recorded from September to December, a period accompanied by the most observations of mating and sparing behavior. Sambar deer in HPNP, inhabiting highland plains of a tropical island, exhibited a reproductive seasonality for both males and females, comparable to temperate cervid species.

Keywords: *Sambar Deer, Antler Cycle, Seasonality, Tropical Cervid*

The Environmental Impacts of Unauthorized Activities in Maragala Mountain Range Environmental Protection Area in Monaragala Divisional Secretariat

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Shifting cultivation, locally known as chena cultivation, is a field of cultivation in which the natural vegetation is cut down, allowed to dry and burned. This system originally belonged to the agro-farming system and falls within the larger scope of sustainable agriculture. In recent decades, however, considerable literature has shown that chena cultivation and the people who use it neglect their environmental responsibilities. Therefore, the purpose of this study is to systematically review the current chena cultivation practices in the dry zone of Sri Lanka from an environmental point of view. The study was conducted in Anuradhapura, Kurunegala, and Monaragala Districts using 20 groups focusing on 10 villagers. Descriptive statistics were used for quantitative data analysis and content analysis was used for qualitative data analysis. With Results revealed that currently farmers cut down all the trees in the premises ignoring the principles of chena cultivation. Mechanical saws have been used for this purpose. 62% of the lands has been prepared using tractors and more than 79% of the farmers has used agrochemicals with their cultivation practices. More than 80% of the sample farmers has removed all trees in their field during the last five years. And 23% of the farmers changes their lands annually as there are separate plots for farmers. Only 12% of farmers reported not cultivating land for at least a year. The human-elephant conflict has been exacerbated by the absence of farmland and the depletion of surrounding forests. More than 20% farmers directly faced elephant attack. The study revealed that the patterns of agricultural land use in traditional arid zone villages have changed significantly over the past few decades.

Keywords: *Illegal Logging, Encroachment, Minimize, Environment protection Area, Forest Fire*

Feeding Habits and Seed Dispersal Potential of the Indian Crested Porcupine (*Histrix indica*) at Udawattekele Reserve Forest, Kandy, Sri Lanka

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The feeding habits and seed dispersal potential of the Indian crested porcupine (*Histrix indica*) were studied in the Udawattekele Reserve Forest, Kandy Sri Lanka ($7^0 17^{'} 55.41^{"}$N, $80^0 38^{'} 40.04^{"}$E) for a period of 15 months from January 2020 to March 2021. This was done to coincide with the four monsoon seasons that Sri Lanka experiences annually. The seasonal downpour effects the growth of vegetation in the reserve, and it was observed that porcupine feeding habits vary throughout the year in accordance with seasonal availability of their preferred food. Observations on direct and indirect evidence for porcupines were made along seven transects within the reserve and one transect bordering the Western edge of the reserve. Porcupine fecal samples were collected once a month along the transects and at burrow sites. Data were also collected from surveys conducted in surrounding residential areas as well as from questionnaires filled by residents owning private gardens adjoining the reserve and from surveilling porcupines that frequented two garbage dumps in the vicinity. This observation shed light on the preference of porcupines for human waste, as garbage dumps made it easy for their foraging and provided a variety of dietary materials including animal bones that were rich in nutrients and calcium. The results of the study suggested that the porcupines' diet was diverse, with tree bark and seeds and tubers being the most consumed. Tree bark damage is quite common in the reserve with porcupines targeting tree species such as Indian kino tree (*Pterocarpus marsupium*) and orange jasmine (*Murriya paniculata*) possibly causing dieback due to exposed trunks. The availability of seasonal fruit and seeds enabled the porcupines to sustain themselves for most parts of the year. However, during dry periods when adequate vegetation was in short supply within the reserve, it was observed that they often ventured out in search of food found in nearby private gardens as well as from local garbage disposal sites. Analysis of fecal matter presented evidence that the porcupines indeed contribute to seed dispersal of certain hemicryptophyte species while a predominant part of their diet consisted of roots and tubers such as some species of Dioscorea (*D. spicata*, *D. pentaphylla*, and *D. oppositifolia*) as well as seeds and fruit such as jak/*kos* (*Artocarpus heterophyllus*) and longan/*mora* (*Dimocarpus longan*). Fecal analysis further showed the seed dispersal potential of crested porcupines and their dietary preferences. Through this method, diversity, pertaining to the diet of the Indian crested porcupine showed a lack of deviation from March to September when the rodents primarily foraged for food within the reserve, feeding on fruit, seeds and bark and were rarely seen outside the reserve, while during drier months (August to late October), when food was in short supply, the porcupines ventured to dump sites and private gardens surrounding the reserve, creating conflict with residents by damaging crops and fences.

Keywords: *Seed Dispersal, Seasonality, Garbage Dumps, Forage, Bark Damage*

Functional Properties of Bioactive Peptides Produced from Crude Water Extract of *Ulva lactuca* Collected from Southern Coast of Sri Lanka

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Ulva lactuca is one of the most abundant green seaweeds in Sri Lanka which is rich in bioactive and functional ingredients. However, only a few types of research have been carried out to identify functional properties of *Ulva* extracts. This study aimed to determine the best treatment to produce bioactive peptides from crude water extracts of *Ulva lactuca* and to determine the functional properties of its hydrolysates. Soluble proteins were extracted with water (sample: distilled water, 1:4) using a previously developed method. They were hydrolyzed by using papain (65^0C, pH 6-7), α-chymotrypsin (25^0C, pH 7-8), elastase (37^0C, pH 8-8.5), and protease (60^0C, pH 6.5-8.5) enzymes (1:100) under their optimum temperature and pH conditions for 0, 3, 6, 9, 12, and 24h, followed with heat inactivation at 100^0C for 15min. The level of hydrolysates was determined by using 15% SDS-PAGE Gel Electrophoresis. According to the results, in all treatments, 0h (only heat inactivation at 100^0C for 15min) were selected as the best since all soluble proteins were broken down into bioactive peptides with the heat treatment. Then functional properties including antioxidant activity (DPPH scavenging activity as say), metal chelating activity (ferrozine method), and antibacterial activity (agar well diffusion method) were analyzed. The antibacterial activity was carried out for locally isolated *Salmonella*, *Escherichia coli*, and *Micrococcus* but no positive results were observed at 20,000 ppm concentration ($P>0.05$). Hydrolysates produced using papain (76.89±0.04%), protease (74.09±0.02%), and α-chymotrypsin (68.08±0.03%) showed strong DPPH radical scavenging activity compared to elastase (44.20±0.17%) ($p<0.05$). However, all the hydrolysates did not show strong metal chelating activities ($p<0.05$) whereas only hydrolysates of α-chymotrypsin (1.50±0.001%) and elastase (0.75±0.0007%) were showed Fe^{2+} chelating activity. Thus, the above results conclude that *Ulvalactuca* hydrolysates which were produced with heat treatment show strong antioxidant activity, low Fe^{2+} chelating activity, and no antibacterial activity for the tested microorganisms.

Keywords: *Functional Properties, Hydrolysates, Ulva lactuca, Water Extract*

The Research Component of the Geoweek 2021 is held in Collaboration with ICSUSL 2021

Global Challenges, Geo-spatial Applications, and Sustainable Solutions

"Geomatics" blends knowledge, concepts, and state-of-the-art technology efficiently and effectively to the application domain enabling us to understand and overcome the challenges we face today. The geo-spatial technological tools including GIS, Remote Sensing, GNSS, Photogrammetry, Hydrography, and Geodetic and Land Surveying have developed continually in the last few decades, and today, they have achieved a matured and operational status. These modern geo tools are being increasingly applied in almost all areas like Mapping, Environmental Sciences, Forestry, Meteorology, Agriculture, Developmental Planning, Urban Studies, Land Management, Archaeology, Civil Engineering, Humanities, Event mapping for example accident, crime, and so on. Therefore, this section intends to cater to all the researchers, academicians, and practitioners working in the field of Geo-Information Science and Technology around the world. It comprises the upcoming technological trends and assists to share insights empowering the people with geo-spatial information. Further, it generates synergy between different interrelated disciplines to come up with viable and sustainable solutions.

Plenary Speech by Professor Walter Timo de Vries

Towards Smart Land Management and Land Administration: Analysis in the Context of Developing Countries

Changes in the practices, regulations and operations in land management and land administration have frequently relied on the uptake of innovations in geospatial technologies. This presentation reviews which types of geospatial technologies the land management and land administration domains have effectively adopted and which new ones might potentially disrupt the domain in the near future of 2021 and beyond in order to make the domain 'smarter'. It starts by providing how one can cluster geospatial technology types on the one hand and land management and land administration practices on the other. The analysis focuses furthermore on the land challenges in developing countries in particular, conflicts and competition for space, monitoring and compliance of spatial rights and restrictions, legitimacy of land tenure and authenticity and completeness of land registers. It furthermore explores how and for which purposes certain type of geospatial technologies are gaining wider societal and institutional recognition in certain subdomains of land management and administration, such as land registration, spatial planning and urban expansion monitoring. While the potentially most disruptive technologies for the domain include the technologies based on Blockchain, Machine Learning and BIM the uptake of big and linked data are increasingly gaining ground in developing countries as well. At the same time, there are also some new concerns arising with the new technologies, which are of particular significance for the required authenticity and security of the type of data, which both land management and land administration require. Such concerns the increasing need to reflect on the ethical dilemmas related to the technologies. Although technical professionals could previously always rely on relatively value-neutral technologies and technological products, issues such as uncontrolled automated judgments and surveillance, deep fake and (geo) privacy infringements are more at stake than ever. The legal and societal impacts are yet still relatively underrepresented in current research.

Prof. Walter Timo de Vries
Chair of Land Management
Department of Aerospace and Geodesy, School of Engineering and Design
Study Dean, Geodesy and Geo-information
Technical University of Munich, Germany

Invited Speech by Professor Jagath Munasinghe

Spaceborne Imaging: Will it Capture the Latent Aspects of Urban and Rural Environments?

In spite of the wide agreement that the urbanization is a process, inevitable and irreversible, its spatial and demographic definitions have throughout been not in agreement. Different definitions of urban areas and urban populations, based on varying socio-spatial characteristics can be noted across countries around the world. The official statistics of Sri Lanka adopted more convenient, but a questionable literal definition, based on administrative divisions, i.e., defining Municipal Council and Urban Council areas as 'urban', and reported that the urban share of its population is less than 20% in 2012, which has frequently been contested, mainly because of the misinformation it provides to policy decisions. In this context spaceborne imagery can be considered as a better alternative to carve out urban areas and to explore the extent of urbanization in Sri Lanka.

Airborne and spaceborne images with the support of remote sensing and the related technologies, enable the interpretation of the state of urbanization of a region as manifested through the physical environmental features such as the built-up area, building densities, the green cover and land use features. The nightlight display is another aspect that has been considered to assess the level and the patterns of urbanization. Yet, do these characteristics reveal the latent aspects of urbanization that matters most for socio-economic development of a nation? This is a matter that needs serious attention of both the urban development and demographic researchers and policy makers.

The presentation will address this question, revealing the phenomenal urban characteristics of the population in Sri Lanka, which are not readily visible in the physical environments. There is a latent urbanizing process that embraces the populations throughout the island and pose many challenges in terms of formulating appropriate policies for national development. The presentation will compare the levels of urbanization as observed through conventional administrative approach and the interpretation of spaceborne imaging with the findings from socio-economic data.

Prof. Jagath Munasinghe
Professor of Town Planning
University of Moratuwa
Sri Lanka

Invited Speech by Professor Thilantha Dammalage

The Present and Future of GNSS

Global Navigation Satellite Systems (GNSS), for example the US NAVSTAR GPS system, the Russian GLONASS system, and the emerging European Galileo and Chinese BeiDou systems are some of the prominent sources for providing globally referenced positioning and timing for multiple autonomous systems used in present and highly potential smart future.

The uninterrupted ability to accurately locate and relocate, navigate and to time synchronise multiple streams has made this exponentially expanding technology that we all utilise, whether we are aware of it or not. Due to the current and future research innovations, and cutting-edge application developments, this technology is becoming an inevitable integration for most of the other sciences, smart technological innovations, and in many more.

However, the performance of the GNSS measurements are highly environmentally dependent and time-correlated. Hence, the current GNSS drivers within the research and engineering community are to improve efficiency, to provide better reliability on real-time/ near real-time accuracies and performance, to meet the requirements of present and future connected, smart, complex, and innovative applications. Improved standalone and augmented estimation algorithms and fusion of GNSS devices with other positioning tools, for examples inertial devices, lasers, cellular and Wi-Fi sensors, etc. are some of the present developments to provide an augmented real-time solutions.

This talk aims to provide some current information on GNSS technology, issues and applications, and a view to the future of GNSS will be given at the end.

Prof. Thilantha Dammalage
Estate and Built Environment
University of New England
Armidale, NSW, Australia

Invited Speech by Dr. Lisa Maria Rebelo

Earth Observation for Agricultural Water Management

Given the scarcity of land and water resources, global strategies to increase food production need to focus efforts on sustainably increasing crop water productivity (or "crop per drop"). Closing the gaps in land and water productivity is a complex task which requires: (i) monitoring of current levels of productivity in various crop production systems; (ii) assessment of observed productivity relative to potential; (iii) identification and analysis of the underlying causes of the productivity gaps; and (iv) evaluation of options and identification of viable solutions to close the productivity gaps in the local context.

Earth observation has the potential to contribute, and the International Water Management Institute works with various partners to support these processes. This includes the analysis of remote sensing datasets and the development of ICT applications based on these to assist farmers to achieve more reliable yields and to improve their livelihoods; and irrigation operators to access new information to assess the performance of irrigation systems and to identify where to focus investments to modernize the irrigation schemes.

Dr. Lisa Maria Rebelo
Principal Researcher (Earth Observation for Sustainable Development)
International Water Management Institute (IWMI)

Invited Speech by Professor Zhenfeng Shao

Urban Impervious Surface Extraction for Sponge City Planning in China

Urban waterlogging and urban heat island effects are typical urban issues, resulting from the rapid urbanization processes. e.g., the transformation of land types with better water permeability in the suburbs to urban land with poor water permeability, resulting in the construction of natural landscapes with vegetation coverage as the main component. Impervious surfaces are artificially constructed surfaces that do not allow water to penetrate. They are considered as a key indicator parameter to measure the degree of urbanization and environmental quality. Regional impervious surface dynamics can affect the spread of pathogens and other non-point source pollutants, posing a potential threat to the health of urban residents. Compared with natural underlay surfaces such as vegetation, impervious surfaces tend to have a stronger solar radiation absorption capacity. Part of the absorbed energy can be radiated outward in the form of long waves, largely changing the thermal environment within a city. Information regarding impervious surfaces distribution has been widely used in urban land use classification, urban population density assessment, urban planning, urban environmental assessment, heat island effect analysis, and hydrological process simulation, etc. This talk will share the urban remote sensing technologies for impervious surface extraction. The requirements for mapping urban impervious surfaces will be introduced. The challenges and strategies of urban impervious surface extraction will be analyzed. This talk will focus on the methods of extracting urban impervious surfaces and will share several applications of Sponge City planning and construction in China.

Prof. Zhenfeng Shao
Professor
The State Key Laboratory of Information Engineering in Surveying, Mapping and Remote Sensing
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Air and Ground Based Imaging for Earth Observation

An Automatic Method for Archaeological Site Detection Using Drone Imagery

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The recent technological advancements in the field of Surveying have changed the process of archaeological surveys. However, it has not been significantly utilized advanced and popular image capturing techniques such as Drone Imagery in the activities of archaeological object detections. Also, the methods and algorithms used in the current drone-captured image processing for archaeological object detection are still immature. The main objective of this research was to automatically detect archaeological objects utilizing drone images and then to perform a comparison between drone-based object detection and the objects identified through traditional archaeological surveys. This research introduces a method to carry out automated archaeological surveys using drone surveying and cloud-based image processing. The drone images were captured over the Ramba Raja Maha Viharaya archaeological site which is also a living monastery situated in the Hambantota District, Sri Lanka. An orthoimage constructed using 87 consecutive images was used for the analysis performed in the Google Earth Engine using a testing algorithm developed in this research. The research is still in its initial stage and the results so far show that the extracted archaeological objects from the drone images are very closely identical to the traditionally surveyed feature layers of the same site been tested. However, it needs more tests to be done with an increased number of images covering a larger area and refinements for the algorithm being developed to confirm the proposed approach. The future version of this research is expected to include deep learning and Artificial Intelligence (AI) based image processing for improved and accurate archaeological site detection.

Keywords: *Archaeological Survey, Automated Survey Techniques, Drone Imagery, Object Detection, Image Analysis*

Assessment of Sugarcane Growth and Development Parameters using Vegetation Indices Derived From UAV-based Imagery

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The sugarcane sector plays a vital role to the global economy, and many investors are attempting to expand production while optimizing resource usage. Effective crop monitoring would be a method to raising productivity while avoiding constraints in the sugarcane sector. Unmanned Aerial Vehicles (UAVs) technology has emerged as a viable tool for agricultural monitoring. In this study, sugarcane growth and development was evaluated by high-resolution RGB images captured from 10.00h to 12.00h using a DJI Mavic pro drone over a 1 ha sugarcane field from tillering to ripening stage in Ampara, Sri Lanka. The UAV configured with flying height, frontal and lateral overlap 50 m, 75%, and 70%, respectively. Green Leaf Index (GLI), Visible Atmospherically Resistant Index (VARI), Green Red Vegetation Index (GRVI), and Modified Green Red Vegetation Index (MGRVI) were four visible vegetation indices that were computed for each flight using mosaicked images, and the best index was selected using fractional vegetation cover (FVC) computed by supervise image classification and kappa accuracy assessment. According to the data, the MGVRI (overall accuracy varied from 94.58 to 98.89%) was the best VI compared to other indices for all phases. The strong correlations between MGRVI and FVC was found for all phases and the highest relationship was found at later grand growth stage (R^2 = 83.9%, SE = 2.58). Crop Surface Models (CSMs) were generated from DEM to extract plant heights per 10 sample plots, and they were validated using field plant heights. According to the findings, correlation between UAV data and field data was strong in the early stages (R^2>80% and SE $<$ 0.06), but weak in the latter stages (R^2< 20% and SE $>$ 0.3). The results showed that UAV technology with an RGB camera is a potential technique for crop growth and development monitoring in sugarcane cultivation.

Keywords: *Crop Surface Model, Digital Elevation Model, Supervise Classification, Vegetation Index, Unmanned Aerial Vehicle*

Automatic Thinning of Bare Earth Lidar Point Clouds

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LiDAR technology is becoming popular among Geomatics user community because of the data provided by this technique have high automation quality and high accuracy compared to data captured by other acquisition methods. Although point clouds generated by the LiDAR technology is being used for various applications, mainly it uses for generation of accurate elevation models and other product outputs such as contours, DEM, TIN, etc. With the advent of science and technology, current LiDAR systems are capable to produce over 20 pts $sq^{-1}m$ which leads for billions of points. Now the problem is processing of such high-density datasets with normal desktop or laptop computers. Very often, computers get stuck due to lack of RAM capacity even they are the cutting-edge technology in computers. In the present, many applications have been developed to rarefy the LiDAR point clouds. However, they are unable to preserve the terrain undulation up to optimum level, so that the expected accuracy of LiDAR data for a particular application could not be achieved. This of course, loses the advantage of having LiDAR point clouds. As such, this study develops a new efficient point reduction approach based on split and merge concept giving focus mainly on splitting. The qualitative assessments confirm that the method is able to maintain the terrain undulation which is mainly based on the user input threshold values. The quantitative assessments further said that the maximum deviation exist below to 0.1m which of course acceptable because the deviations fall within the elevation accuracy limit of the point clouds. As such, thinned point clouds obtained from the method will be greatly benefitted to maintain the relevant accuracy of a particular application.

Keywords: *Automatic Thinning, LiDAR Point*

Automatic Window Boundary Extraction from TLS Point Clouds

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3D city models are important for many purposes, such as urban planning, safety mapping, and so on. Initially, urban planning is generally limited to 2D design plans, which may difficult to interpret in detail. With the complexity of modern architectural designs of buildings, the interpretation further hampers. But with the development of computer technology, the reconstruction of 3D city models even in large cities is achievable though the automation is still a challenge. The traditional method of reconstructing 3D building is based primarily on manual reconstruction on top of 2D building footprints with the help of aerial images, or semi-automatic reconstruction from aerial images. The manual reconstruction of a city model is a rather time-consuming and costly process because of the huge number of urban features in a city and the variety of shapes. Typically, Terrestrial Laser Scanner (TLS) points contain useful information, and may be a valuable source of data to recreate 3D city models. The study introduces a new building facade feature extraction algorithm from TLS point clouds automatically. This is achieved by the recognition of object holes automatically from the point cloud automatically. The experiments results show that the automated building facade feature extraction algorithm, developed in this work, performs well with the 100% detection rate. The geometric accuracy of the extraction is greater than 5cm at the vertical wall surface in XZ axes. As such, it can be concluded that the developed approach could be easily applied for real projects in large cities.

Keywords: *3D City Models, Urban Planning, Façade Feature Extraction, Point Cloud, TLS*

Feasibility Study on Implementation of Videogrammetry for Road Surveying

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Road surveying plays an integral role in the development of the country with its involvement in the design, construction and maintenance phases of the country's road network. The widely used technique in the road construction industry of Sri Lanka is the geodetic surveying using total station and auto level. Usually, Global Navigation Satellite Systems (GNSS) is also being combined with the popular geodetic surveying methods. As a recent trend, airborne remote sensing is also being adapted for road surveying apart from the popular surveying methods. But, an effective method for surveying roads under dense canopy has become a timely challenge for the industry. Precise 3D modelling using ground based Mobile Mapping System (MMS) kits are novel approaches in the geospatial industry. However, the instrumental and technological costs are quite demanding. LiDAR, close range photogrammetry and GNSS are well known MMS technologies. Videogrammetry is a branch of photogrammetry which uses consequential photo frames in a video. The study evaluates the feasibility of videogrammetry in surveying of rural roads with minimum resources. Videos captured from a smart phone camera are used for 3D modelling together with a set of ground based structural dimensions collected in the sampling site. The outcomes establish the possibility of creating a 3D model using a video captured from a ground mobile platform to derive a quality output with 2cm horizontal and 3 cm vertical accuracies. Further, the model preserves the shapes and topology of the road surface and road furniture. Similar 3D models can be employed for the monitoring and maintenance of utility infrastructure in rural areas as a time and cost effective alternative.

Keywords: *Photogrammetry, Road Surveying, Rural Roads, Mobile Mapping Systems*

Implications of Unmanned Aerial Vehicles for Identification of the *Oidium* Leaf Disease of Rubber Plantations : A Review

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With the ever-growing global population, the agriculture sector faces the challenge of providing innovative solutions to meet the production demand and maintain its sustainability. Sustainable agriculture, however, needs to embrace regular monitoring of the crop growth against their pest and disease incidences mainly. When contemplating the global rubber industry, *Oidium* leaf disease is one of the most common diseases which cause significant economic loss. As such it requires urgent attention on early detection and monitoring of this rubber disease. With the advent of technology, most of the developed countries are now focusing on the potential of the utilization of remote sensing advancements, mainly low altitude aerial sensing equipment like Unmanned Aerial Vehicles (UAV) with multispectral and hyperspectral sensing capacity to systematic monitoring of the pest and disease incidences. Accordingly, literature research has been conducted to find out the potential use of UAVs on the identification of *Oidium* disease at the early stage. Literature highlights that, in different health conditions, the rubber leaves absorb and reflect different wavelengths. Accordingly, it shows that the characteristics of *Oidium* leaf disease can be mainly identified through the variation in reflectance of the associated bands of the multispectral images, especially the RGB band (0.4μm-0.7μm) and NIR band (0.7μm-2.0μm). These bands can be utilized to distinguish the health conditions of rubber leaves. But when critically reviewing the papers, NIR is the region that can be identified as the most potential region to use when locating the regions affected by *Oidium* leaf disease and then the site-specific application of the remedial chemical pesticides can be done to turn the entire system into a cost-effective one. Thus, the review highlights that multispectral images can be utilized to detect *Oidium* leaf disease of rubber plantations by using reflectance characteristics of rubber plantations.

Keywords: *Agriculture, Unmanned Aerial Vehicles, Multispectral Images, Rubber, Oidium Leaf Disease*

GIS and Mapping

Assess Elephant Habitat Suitability using Remote Sensing in Sri Lanka

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The Elephant is the largest animal in all Asian countries. The Existence of elephants is rare, mostly owing to habitat loss. Surviving areas of appropriate elephant habitat are essential to be secure from human development and also from the elephants themselves. Thus, execution of methods for the area where elephants are usually present is a challenge and needs a large volume of resources and time. As such, it is vital to implement a cost-effective method for assessing the present and possible elephant habitats. The objective of this study was to utilize Remote Sensing techniques in identifying the habitats of elephants. The study was carried out in the Hambantota, Ratnapura, Monaragala and Kurunegala district wildlife region. Timely accurate satellite data (Landsat 4, 5, and 8 with medium resolution acquired in the year 2005, 2007, and 2013) were used to analyze the behavioural patterns of wild elephants by taking advantages of semi-automatic and automatic advanced image processing algorithms rather than using conventional mapping methods. Two supervised classification methods, Neural Network (NN) and Support Vector Machines (SVM), were used to identify the possible elephant habitat boundary areas by using the training data. This was followed by Decision Tree (DT) classification to classify the elephants' living and non-living areas. The predicted elephant preference area was matched and accuracy was checked with the actual preference areas generated using GPS collar data. It was shown that the proposed DT-based model could be applied in envisaging areas that fit elephants with 83%, 72.5%, and 85.5% for the years 2005, 2007, and 2013 respectively. Thus, the method can be used in real work. The method could be enhanced by including various parameters more related to elephant disturbances.

Keywords: *Elephant, Human-Elephant Conflict, Habitat Preference, Remote Sensing*

Automatic Symbol Generating from *AutoCAD Civil3D*

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Earlier days to the present, survey drawings or plans have been an important part of any construction work in any country. When it comes to the survey of smaller areas, the data surveyed by the surveyor can be shown in a larger scale plan and the details can be shown on the plan very precisely. But when it comes to a larger area, all the details surveyed by the surveyor cannot be drawn by lines. It means some point data should be shown using point symbols. Normally, while surveying the construction areas, road surveys, and topographic surveys, point observations should be done to identify the features on the ground. These points should be visualized on maps by using point symbols such as hydrants, telephone posts, electrical posts, manholes, telephone poles, light poles, and fiber optic cable markers, etc. Therefore, point symbols are more important for surveying drawings.Applying the same symbol for a number of locations is not an easy task for the surveyor or draftsmen when applying the traditional copy and pasting method. Therefore, an automatic symbol generated using the Description Key for the same feature in different locations can be done using the *AutoCAD Civil3D*. By using the automatic symbol generating method, surveyors and draftsmen can minimize the errors that can crop up due to personal errors and their limitations. When considering the final output of this study, it can be mentioned that copy and pasting (manual) method can be upgraded to an automatic symbol generating method and symbols for single-point observations can be completed within few minutes.

Keywords: *Symbol, Topography, Scale, Description Key, Civil 3D*

GIS and Remote Sensing Assisted Land Degradation Analysis in the Wilpattu Area, Sri Lanka

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Land degradation (LD) shows as one of the largest global challenges for the human's livings and environment. Land degradation refers to a change in the health status of the soil which results in a reduction in the capacity of the ecosystem to provide goods and services to its beneficiaries. The degradation of the land is happening always with different land conditions such as physical, chemical and biological and various human activities. Thus it is highly important to analyse the Land degradation changes and examine the factors which most affect the land degradation with its changes are useful for the sustainable management of the resource. Land Degradation Index (LDI) is one of the most effective models to visualize and asses the degradation changes. The present study aims at monitoring land degradation process of the study area in Wilpattu, Sri Lanka. To fulfil this objective, Landsat ETM images are used to produce the LDI map of the studied area at the landform level. Enhanced Vegetation Index (EVI), the Modified Normalize Difference Water Index (MNDWI), Normalized Difference Sand Dune Index (NDSDI), Index Based built up Index (IBI).parameters were assessed using RS and GIS techniques. In the study, Landsat images of 2011, 2015, and 2019 were used. The land degradation risk in the study area has increased by 13.802%, 18.354% for the period of 2015-2011, period of 2019-2015 respectively.The result of this research work could be potentially used as a useful tool to guide policy decision makers for sustainable land resource management in Wilpattu area.

Keywords: *Land Degradation,GIS, Remote Sensing*

Risk and Spatial Pattern Analysis of CKDu in Sri Lanka: A Case Study in Monaragala District

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Chronic Kidney Disease (CKD) is a global health burden with a high economic cost to the health systems and it has become a high-risk factor of cardiovascular diseases in agricultural communities. In the last two decades, Chronic Kidney Disease of unknown aetiology (CKDu) has emerged as a significant contributor to the burden on the healthcare system of Sri Lanka. Understanding the spatial distribution and spreading patterns of the CKDu patients along with the contributing factors will immensely be benefitted for further research, patient management, policy development and decision making. This study aimed to geographically analyze the aetiology factors which are influenced by the distribution of CKDu. To fulfil this aim, details of a group of one hundred affected patients were collected from the regional health service of the Monaragala district. This included the patients' location information which was used to identify the causative factors related to CKDu. This study used the SPSS statistical tool along with R programming for quantitative and geostatistical analysis and a GIS-based hot spot analysis along with a weighted sum technique to identify the risk of CKDu and the spatial distribution in Sri Lanka. CKDu prevalence distribution was analyzed as the normalized value of the number of patients and population over the GND while producing a density map with count per dot as a patient by using the number of CKDu patients in Monaragala. This study identified that for every increase in one unit of the logged population density the kidney patient density increases by $e^{0.807}$ units in Monaragala district. Moreover, the probability of patients who are over 30 years old is increasing in Kataragama, Thanamalwila and Wellawaya DS Division area than the other DS division in Monaragala District. The outcomes of this study may help to control and prevent the CKDu distribution in Sri Lanka.

Keywords: *Chronic Kidney Disease (CKD), Chronic Kidney Disease of Unknown Aetiology (CKDu), GIS, Spatial Analysis, Risk Analysis*

Space Borne Imaging for Urban and Rural Environments

An Analysis of Surface Green Cover Change and Urban Expansion in the Major Cities of Colombo, Kandy, and Galle

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Urbanization refers to the process by which rural areas become urbanized as a result of economic development, industrialization and the expansion of population. With the development decade beginning in 1945, human activities toward the biotic environment have expanded. Because of that, the physical environment is becoming insufficient for human consumption. This specific global trend is being studied to give priority to Sri Lanka in terms of temporal and spatial aspects. The primary objective of this research was to analyse the changes in green coverage and the expansion of build-up areas with respect to the scale of time and space. The Colombo Metropolitan area, Kandy cultural city and Galle Fort have been selected as the study area for this research. The entire analysis is based on secondary data sources, with pre-processed Landsat images downloaded from Earth Explorer website in 1997, 2008 and 20018. Arc map 10.4 software has been used in analysing data and examining the pattern of Normal Difference Vegetation Index (NDVI) in cities specified. In addition to that, statistical software (excel) has been used in this research to obtain the final results. The result shows that urban lands had been expanded drastically into sub-urban lands and vegetation cover was also being decreased considerably. In the Colombo municipal area, broad and rapid urbanization could be seen in comparison to the other two cities. The distribution of thick forest cover in Colombo was 8.5 km^2 in 1997. But this amount has been gradually decreased and is limited to up to 1.6 km^2 by 2018. When considering the Kandy municipal area, a low expansion of Build-up land can be observed relative to Galle and Colombo. The main factor is that Kandy city is located in the central mountainous area. The cities that are located in the coastal belt directly face the rapid urbanization process. Urban green city planning science and engineering techniques should be practically applied to the main urban hub areas. It will be really helpful to create human comfort cities.

Keywords: *Land Use, Urbanization, Green Cover, Build-up Areas*

Evaluation of Machine Learning Algorithms in Classifying Multispectral Imagery on Waterbody Extraction

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A comprehensive study for utilizing multispectral satellite imagery to enhance novel environmental monitoring techniques is crucial in terms of accuracy, processing time, and cost for a sustainable triple bottom. The accurate classification of water bodies from other features optimizes spatiotemporal analysis to address global challenges. Therefore, this study emerges as the new research frontier in proposing an apt algorithm for recognizing water resources and coastline in Sri Lanka. This study explores the potential of using classification algorithms for geospatial assessments and applications with their accuracy and reliability. The acquired Collection 2 Level 2 Landsat 8 imagery was geometrically and radiometrically pre-processed, and a false-colour composite was produced from the bands: short-wave infrared, red and near-infrared. A total of 280 training samples were created with the reference pixels of 50.13 percent for water bodies and 49.87 percent for other features. The confusion matrix was generated using a distinct set of 500 random points for each classification technique, and the F-score and kappa coefficient were calculated for the accuracy assessment. The study depicts that the supervised algorithms: Support Vector Machine, Maximum Likelihood and Random Trees, and unsupervised algorithm: ISO Cluster performs equally in classifying water bodies and other features with higher kappa coefficient exceeding 0.95. Out of these, ISO Cluster was efficient than other algorithms due to reduced handling time. The findings enhance the decision-making ability on extracting surface water bodies using freely available 30 m spatial resolution imagery.

Keywords: *Classification Algorithms, Kappa Statistics, Multispectral Imagery, Waterbody Extraction*

Quantification of Greenhouse Gas Emission from Construction Materials Used in Urban Cultural Heritage Buildings in Sri Lanka

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Anthropogenic activities have a significant impact on the natural environment. The majority of greenhouse gas emissions that contribute to the climate crisis are emitted by buildings. Adaptive reuse of buildings has been highlighted as a sustainability concept that is primarily applied with historical structures and one of the strategies for reducing the environmental effect of building constructions. This study calculated the embodied carbon savings from adaptive reuse of Sri Lanka's urban cultural heritage buildings. The sample consists of five purposively selected historic buildings from the Dutch era. During the site visits, the materials and techniques used in construction during the Dutch era, as well as floor plans and measurements of building elements, were collected. The floor plans were drawn up and the material quantities were estimated. The greenhouse gas emission from construction materials was calculated using the estimated material quantities and the emission factor values. The selected five cases revealed that the average greenhouse gas emission of Dutch era historic buildings is 432.26 kg $CO_{2\text{-eq}}$ m^{-2}. The main building materials used during the Dutch era were granite, clay, limestone, and timber. Granite is the primary source of greenhouse gas emissions (40.93%), while clay contributes 34.56%. The greenhouse gas emissions of construction materials used in Dutch era historic structures are lower than those of modern constructions using new materials, according to the findings of this study and previous literature on embodied carbon assessment of modern buildings. As a consequence, the findings of this study may indicate that adaptive reuse of urban cultural heritage buildings is more environmentally friendly than new construction since it prevents additional high greenhouse gas emissions. This may also aid in the development of initiatives to promote the concept of adaptive reuse of urban cultural heritage buildings in Sri Lanka while reducing environmental effect.

Keywords: *Adaptive Reuse, Construction Materials, Cultural Heritage Buildings, Environmental Impacts, Greenhouse Gas Emission*

Spatial Variability of NDVI and LST in Colombo District, Sri Lanka

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Land surface temperature (LST) is a fundamental aspect of climate and biology, affecting organisms and ecosystems from local to global. National Aeronautics and Space Administration (NASA) and other international organizations have identified Land surface Temperature (LST) as one of the most essential Earth system data records for measuring thermal radiation from the Earth's surface, where incoming solar energy interacts and heats the soil or canopy surfaces in vegetated areas. With the Rapid Population growth, Urbanization, and Land Use changes, an increase can be detected in the LST in world's urban areas and Sri Lanka. This situation can be identified in Colombo District as the fastest growing area in Sri Lanka. This study mainly focused on analyzing LST spatial distribution changes with Normalized Difference Vegetation Index (NDVI) from Colombo city to suburbs in Sri Lanka. The Landsat 8 satellite data was downloaded from the USGS (United States Geological Survey) Earth Explorer website to calculate the NDVI and LST in Colombo District for the year 2015 and 2019. The Multiple Ring Buffer Tool in ArcGIS 10.1 software was used to create the 1km concentric rings from the CBD (Central Business District) and extracted the Average NDVI and LST values to the concentric rings using the Zonal Statistics tool. All analyses were carried out using ArcGIS 10.1 and MS Excel 2013 software. The results revealed that LST ranged between 34.53 ^{0}C and 23.10 ^{0}C and had an Average value of 26.39 ^{0}C in 2015. In 2019 Average LST was 27.22 ^{0}C, while LST ranged between 35.95 ^{0}C and 23.14 ^{0}C. Furthermore, it can notify the average LST values were increasing and the average NDVI values were decreasing when moving away from the CBD in 2019 more than in 2015. This kind of study enables us to measure current situations and identify past situations and patterns of LST in urban areas. It has the potential to forecast future LST changes. It enables us to take long-term action on potential problems in the future and find answers to potential problems in the future.

Keywords: *Land Surface Temperature, Normalized Difference Vegetation Index, Land Use Change, Concentric Rings*

Use of Satellite Images for Urban Form Detection: A Case Study of Ratnapura MC Area

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As a result of the urban expansion, the urban forms of the city area are being changed year by year. The physical shape of the city can be called urban form. The Remote Sensing and GIS (Geographical Information System) is the main component to identify correct urban form for the decision-makers as well as urban planners in town planning. Urban expansions are a problem of any city for future developments. Ratnapura MC (Municipal Council) area is selected as the study area in this research and infrastructures of the city are changing rapidly from the year 1995. Therefore, understanding their urban form is a valuable thing for future developments. The main objective of this research is detecting the urban forms of the Ratnapura MC area and the sub-objectives are identifying the direction of built-up area expansion and finding the density of the built-up area in percentage and urban expansion index. The NDBI (Normalized Difference Built-up Index) was used for extracting built-up area. The Landsat 7 and 8 images were used for extracting the built-up area from the year 1995 to the year 2020. In 1995 the urban form was clustered and gradually diverted towards linear form. The direction of urban expansion was to north and southeast directions. The urban expansion of built-up area from 1995 to 2005 is identified as 14% and from 2005 to 2015 it was 8%. However, from 2015 to 2020, the built-up area was increased by 1%. The urban expansion is not spreading towards west from the city centre due to Kalu Ganga. The main street is the easiest way to access other parts of the settlements. Therefore, the demand for the lands on either side of the street is very high due to the city's development as a linear urban form. This may not occur if urban forms have remained clustered.

Keywords: *Built-up Area, NDBI, Remote Sensing, Urban Forms*

Positioning and Navigation

A Geometrical Perspective of the Elliptical Movement of the Planets a Consequence of Two Circular Forces Directed towards the Foci

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Kepler's law of planetary motion describes the motion of planets around the sun. According to the Copernicus paradigm, planets orbit the sun in a circular orbit. Later, eccentricity studies revealed that planetary orbits are ellipses rather than circles. Newton's gravitational theorem is based on this basis. Furthermore, these methods raise the question of how the circular forces of the planets form an elliptical path with a single focus point. The link between centrifugal forces and elliptical orbit was investigated in this study. Geometrical and numerical analysis are the emphasis of these interactions. (1) Ellipse formed by two circular forces acting upon an arbitrary point (Planet). (2) These circular forces are directed to the foci of the Ellipse. (3) At every location, the angle created by an elliptical and a circular tangent equals half of the angle formed by their respective circular orbital tangents. These relationships between the two circular forces cause the planets to follow an elliptical orbit.

Keywords: *Elliptical Movement, elliptical Orbit, Copernicus Paradigm, Foci*

Assessment of CORS Real-time Kinematics (RTK) Measurements on Geodetic GNSS Receiver and Unmanned Aerial Vehicle (UAV) in Sri Lankan Survey Perspective

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Utilizing the CORS corrections on GNSS and drone surveys improve the productivity of surveying, serving as an ultimate solution for the demand of fast, high-detailed and effective surveying. Though, the manufacturers demand sub-centimeter accuracy,it is important to investigate the achievable real-time accuracy of UAVs, replicating the real-world surveying scenario in Sri Lanka. This study comparatively analyses the accuracy and suitability of (i) short-baseline (SBRTK) of 0.70 km, (ii) long-baseline (LBRTK) of 40 km and (iii) network-based RTK (NRTK) in VRS mode for drone solutions with that of GNSS and total station measurements. A field survey was performed within 0.5 Ha commercial area equipping Leica manual total station, Stonex S900 GNSS receiver and DJI Panthom-4 RTK drone. Flight height of 50 m was maintained with 70% and 80% of side and front overlaps respectively utilizing the RTK corrections of CORSnet, SULECO (Pvt) Ltd. Solutions of GNSS and drone surveys were statistically compared with that of terrestrial survey measurements. Results indicate convincing performance of GNSS-RTK and RTK-Drone survey with centimeter-level accuracy. An ambiguity "Fixed solution" was obtained with an average of 27 common satellites during SBRTK and LBRTK where it was only 12 on NRTK which could be due to the process of integer ambiguity fixing. The GNSS survey on NRTK provided better results (maximum standard-error (SE) of ±6.4 cm)in comparison with SBRTK and LBRTK solutions and the Standard Deviation (SD) decreased as LBRTK (2.3 cm), NRTK (1.7 cm), and SBRTK (1.6 cm). The results of RTK-Drone survey were irrespective of the solution mode witha maximum SE of ±5.0cm in north and ±4cm in east and the SD was within a marginal variation between 0.9 to 1.3 cm. Though establishment and maintenance costs of NRTK are comparatively high, it provides better accuracy irrespective of the survey method. The drone survey yields, comparatively better accuracy than GNSS-RTK survey irrespective of solution types in drone friendly environments.

Keywords: *CORS, GNSS, Network RTK, Surveying, UAV*

Detection of GPS-Levelling Datum Variation using Heterogeneous Data: A Case Study in Sri Lanka

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Geodetic datum is a fundamental reference surface in positioning and plays an important role in relation to the survey activities of a country. Sri Lankan horizontal datum, SLD99, was established in 1999 using Global navigation satellite system, GNSS, technology, and the vertical datum (levelling datum) was fixed averaging 6 years of tidal observations from 1884 to 1890. This research investigates potential inconsistencies of Sri Lankan GNSS and levelling datums. For the analysis, heterogeneous data such as long-term tidal, GNSS, levelling, global geoid and Mean Dynamic Topography, MDT, heights around the coastal region were used. Tidal analysis reveals that the tidal Mean Sea Level, MSL, around the country is linearly varied with increasing rate of 3mm per year. By analysing GNSS, levelling, MDT and global geoid heights, it is found that there is a 1.884 m vertical deviation in Sri Lankan GNSS datum with respect to the latest realization of International Terrestrial Reference Frame, ITRF, and MSL based levelling datum is capable of representing global geoid features.

Keywords: *Geoid, Tidal Analysis, GNSS-levelling, MSL*

Rapid Assessment of the Channel Clearance for Safe Navigation due to Fire-stricken 'MV X PRESS PEARL' Colombo Port, Sri Lanka

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The recent accident of the MV X Press Pearl caused a massive threat to the safe operation of the Colombo Port. She was carrying about 1486 containers and due to this incident, many of them and other debris might have fallen into the navigation channel and an urgent hydrographic survey has conducted in early June 2021 to confirm the clearance for safe navigability. A detailed Side Scan Sonar survey was conducted in the area by the Faculty of Geomatics, Sabaragamuwa University of Sri Lanka with the collaboration of Sri Lanka Ports Authority in order to confirm the channel clearance. The Side Scan Sonar is an effective tool in rapid hazard investigation of a large area, and from this survey it was successfully confirmed that the critical port operation area is safe for navigation. Several containers and other debris were found lying on the seabed about 4-6km away from the channel where the MV X Press Pearl was grounded. However, further surveys needed to be conducted in a systematic manner in the entire area including the port anchorage for full investigation in order to ensure that the area is clear for the ship anchoring and local fishing activities and to eliminate the future threats due to the current dragged debrides.

Keywords: *Rapid Assessment Survey, Navigation, Hydrography, Side Scan Sonar*

Managing Global Challenges through Fostering Innovation and Creativity

In recent years, the need to address social and environmental challenges has grown in urgency. Climate change, global health issues such as the COVID-19 pandemic, food security, and many other global challenges cross national borders and affect a wide range of business organizations, ranging from not-for-profit to profit and small-scale to large-scale. Consequently, global challenges call for innovative and creative business models cooperating with various business disciplines such as management, marketing, information technology, tourism and hospitality, and finance at both national and international levels. The subsequent section covers research findings on the aforementioned disciplines.

Plenary Speech by Professor WMC Bandara Wanninayake

Digital Transformation as a Remedy for Marketing Myopia in Times of Covid-19

Marketing Myopia, first expressed in an article by Theodore Levitt in Harvard Business Review, reveals the notion of short-sighted and inward-looking approach in marketing providing insights on strategic directions for organizations. Marketing Myopia strikes when the sales function becomes the central focus of a company's marketing strategy, which inhibits the potential of the marketing management. Myopic organizations lack insights on dynamic consumer behavior and its implications on the survival of the organization. Past researchers suggest that a myopic organization can be identified if they are selling-oriented, short-sighted, engaged in unwanted quality improvements, and is ignorant to the dynamic consumer environment. From a broader perspective, it is evident that during the Covid-19 outbreak, many businesses failed as they were unresponsive to the changing demands of the marketplace particularly with the trend of consumer adaptation on digital transactions by breaking the conventional frameworks. Alongside, customers embraced online payment options, mobile platforms for ordering daily essentials, and other online platforms by naturally accepting the sudden change. Businesses which were quick to respond to the rapid changes in customer expectations could survive the unexpected blow. Organizations which did not have the capacity and the capability to adapt the change faced a strategic drift and a flux. This is a classic example of a modern-day marketing myopia.

Researchers and business consultants are proposing different solutions to avoid being myopic in this pandemic. Digital transformation is one of the prominent solutions suggested by them for most organizations. Digital transformation is a holistic transformation of businesses organizational activities, processes, competencies, and models to fully leverage the changes and opportunities with a mix of digital technologies. The accelerating impact of the digital transformation can be extended across society in a strategic and prioritized way in line with present and future shifts in mind. Based on the digital transformation framework, four areas such as digitalizing the customer experience, digitalizing the product and services, digitalizing the organizations, and digitalizing the operations should be focused within the transformation process. In this process, different levels of technology-enabled business transformations are needed. Further, it is observed that digital transformation can benefit organizations in numerous ways such as, enabling employees for better performance, better engagement with customers, optimizing the operations, and transforming products based on the system of intelligence. Accordingly, digitally transformed businesses can have a paradigm shift with a revolutionized change in iden-

tifying and satisfying customer needs not only in pandemics, but also in any turbulent situation by avoiding marketing myopia.

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Education, Marketing, Tourism and Environmental Management

A Review: Critical Analysis of the Impact of Global Warming on Business Innovations

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Global warming has created enormous changes to ecology, human lifestyle and economic behavior. "Take urgent action to combat climate change and its impacts" which is stated in 13th of United Nations sustainability goals, shows the importance of fight against global warming. Global warming influences businesses to take strategic decisions and upcoming plans considering impacts on Ecology, Society and Community in long run. Objective of this study is to critically analyse the impact of global warming on business innovations. A systematic review method that involved considering several questions including the following: (a) What are the major potential impact of Global Warming? (b) What are the new Business opportunities with Global Warming? (c) What are the new Business Innovations dealing with global warming? A literature survey has been conducted by stating 74 scientific articles based on keywords of impact of global warming, business innovations, and business opportunities. Study critically analyzed the major risks and threats to business caused by global warming, new business opportunities with global warming, new business initiatives with global warming and new business innovations with global warming. Major industries have threatened by direct and in-direct impacts of global warming. Some challenges to business are caused by regulations while others are due to in-direct impacts to industries. Most profitable industries incurred huge losses in recent years while those who adapt appropriately were able to sustain in the market. Some new market opportunities are created and businesses with innovative ideas are winning the market competition. It can be concluded that businesses which do innovative applications and adapt in to market dynamics well are found performing well in economy against the global warming.

Keywords: *Global Warming, Business Innovations*

Current Status of Aqua-based Tourism Activities in the Southern Coastal Regions of Sri Lanka

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Aqua-based tourism is one of the trendiest sectors that contribute to increasing the income of the total tourism industry in a country. Although many aqua-based recreational tourism activities are being implemented within Sri Lanka, systematic awareness and advancements within the scope are still absent. Thus, the study was designed to identify and categorize aqua based recreational tourism activities on the Southern coast of Sri Lanka and to assess their impacts on the environment. Data were collected by a questionnaire-based survey from foreign and local tourists, activity operators, trainers, tour guides, and other relevant stakeholders as per the stratified random sampling method and by secondary data sources. Results revealed that, thirty-five aqua-based recreational tourism activities that belong to twenty major tourist destinations are occurring remarkably along the Southern coast. All of them could be categorized into five categories as "Water sports", "Traditional fishing activities", "Marine wildlife tourism", "Underwater activities", and "Beach tourism". Among those categories, Water sport (33.4%) has been identified as the most popular category according to tourist's insight. More than 50 percent of tourist attractions have been aggregated to Unawatuna, Hikkaduwa, and Mirissa destinations, even though the boat riding in Bentota was identified as the most attractive sole activity. Moreover, disqualified tourist activity operators, lack of facilities and inadequate government support were identified as the factors that negatively affected the development of the industry and tourist's despondency. The tourists' perception revealed that sport fishing, deep-sea fishing, and whale watching are the most destructive activities that adversely affect the respective ecosystems. Therefore, proper awareness of those activities among tourists and implementing effective management techniques are recommended to be adopted for the sustainable development of the industry.

Keywords: *Beach Tourism, Marine Wildlife Tourism, Traditional Fishing Activities, Underwater Activities, Water Sports*

Evaluating Tourist Expectations, Perceived Value, and Satisfaction of Tourists in Sri Lanka

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The tourism industry has become a pillar that holds the Sri Lankan economy. The world travel and tourism sector in 2019 has contributed US$ 8.9 trillion to the global GDP. Tourism is a method of generating foreign exchange which helps to control the balance of payment of US$ 35.3 billion of Sri Lanka which was due up to year 2020. There is significant slow growth and fluctuation in the European tourist market before the COVID-19 pandemic. It's important to identify the reason for slow growth and fluctuation in the European tourist market and it will be useful to improve the tourist industry in Sri Lanka. The main objective of this study is to evaluate the expectations, perceived value, and satisfaction of Tourists' who are visiting Sri Lanka from the European region. The data was collected using a questionnaire covering expectation, perceived values, and satisfaction in the aspect of accommodation, transport and services, food and beverages, health and safety, and attractions and activities. A total of 269 tourists visited from Europe in 2019 were used on analysis from the convenience sampling method as the sample size. Tourist expectations have been analysed against the perceived values initially. Then expectation and perceived values have been analysed against the satisfaction. It is concluded that there is a positive significant relationship with all the variables. Among them, the expectation prevails as the most significant precursor of the tourists' satisfaction rather than the perceived value with satisfaction. The decision makers in the tourism industry in Sri Lanka should devote more efforts to improve the facilities for accommodation, transportation, health and safety and food quality.

Keywords: *European Region, Expectations, Perceived Values, Satisfaction, Sri Lanka Tourism*

Prediction of Construction and Demolition Waste Generation of Residential Projects in Sri Lanka

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A considerable amount of construction and demolition (C&D) waste is generated every year in Sri Lanka causing huge harm to the natural environment. Managing C&D waste has become a very important and timely requirement in the country as it cannot be illegally disposed of to the environment. Therefore, strong C&D waste quantification methods are required to manage C&D waste disposal. Main reasons to demolish a residential project in Sri Lanka are to increase property value, buildings with weak foundations, before putting the property on sale and buildings in need of endless repairs. Moreover, analysing additional techniques of waste generation is important apart from those already identified because of the absence of attention paid to the sizes of the used products in construction, lack of influence of contractors, and lack of knowledge regarding construction throughout design activities. This study is conducted based on different residential construction project plans and bills of quantities to quantify the construction wastage. This study mainly used a combination of the Generation Rate Calculation method and the Lifetime Analysis method for quantifying waste factors from plans and Bill of Quantities. Addressing the unavailability of proper methods to predict quantities of C&D waste generation in Sri Lanka this paper suggests a method to improve the accuracy of C&D waste generation prediction using machine learning using random forest (RF) and K-nearest Neighbour (KNN) algorithms. Gross floor area, roof material and no of stories are taken as input variables of the model and quantities of mortar, concrete, bricks, roofing tile, asbestos, metal and timber taken as output variables. Predicted quantities of wastage can be managed in a reusable manner making it profitably and harmlessly. Further, it can reduce resource wastage in construction sites and minimize environmental pollution that happens due to construction as well as demolition activities.

Keywords: *Construction & Demolition Wastage, K-Nearest Neighbour, Machine Learning, Quantifying C&D, Random Forest*

The Status of Kite Surfing Industry in Kalpitiya Lagoon, Sri Lanka: Issues and Challenges

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The Kalpitiya lagoon on Sri Lanka's north western coast has been recognized as one of Asia's best kite surfing destinations, and this study used a questionnaire-based survey with 70 stakeholders (kite surfing instructors and whom involved with other related supply and service activities) to assess the current state of kite surfing in the Kalpitiya and identify potential challenges as an emerging sport. Descriptive statistical methods including frequency distribution were used for data collection and data analysis. According to the respondents, Kalpitiya lagoon is the best location for kite surfing in Sri Lanka because it has adequate seaward winds for nine months of the year (May to October and December to March), and it is free of other human activities and natural barriers like boundary vegetations in the region where kite surfing activities are conducted. It's also a great area for beginners to learn how to kite surf. All individuals engaged in kite surfing were under 50 years, whereas the majority (64%) were under 30 years. 21% work as direct kite surfers and trainers while the remaining associate with supply and services. Furthermore, foreign instructors are frequently or occasionally hired by 85% of operators due to inadequate practice and knowledge with local stake holders. The majority (56%) of the foreign tourists came from European countries such as Germany, United Kingdom, and France, followed by Russia and Australia. Additionally, these stakeholders had engaged with other income-generating activities such as whale and dolphin watching (43%), wildlife tours (26%), diving and snorkeling (17%), and other recreational activities (14%) during the off-season of kite surfing. Present challenges for kite surfing are the high cost of equipment, low popularity among local tourists and the COVID-19 pandemic. Further, the stakeholders and the government have no direct ties for the kite surfing industry; therefore, an effective management strategy should be implemented right away to ensure the industry's long-term viability.

Keywords: *Coastal Tourism, Kite Surfing, Development, Tourism in Sri Lanka*

General Management,Information Technology and Administration

The Experiences and Reactions to Greenwashing from The Perspective of Green Consumers in Sri Lanka: A Qualitative Research

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Greenwashing is pervasive in the global market. Evidently, greenwashing is a phenomenon that must be eliminated from the market. Though the majority of the research on greenwashing is available in developed country contexts, the knowledge on the experiences of greenwashing and responses to greenwashing by consumers are scarce in developing Asian country contexts such as Sri Lanka. Therefore, this study explores the consumers' experiences of greenwashing and the reactions to greenwashing in Sri Lanka. Being based on the Interpretivism paradigm, we used the qualitative methodology. We purposefully selected eleven supermarket consumers who have done higher studies in environment-related study streams and conducted in-depth interviews to collect rich data. We employed thematic analysis to analyze the qualitative data gathered from the respondents. The respondents revealed that they had experienced two main types of greenwashing activities: false green claims and false green images. Notably, green supermarket consumers react to greenwashing in various ways, such as taking actions against greenwashing, expressing feelings against greenwashing, and suggesting ways to react against greenwashing. This paper contributes to greenwashing literature by uncovering the green supermarket consumers' experiences of greenwashing and the reactions to greenwashing in Sri Lanka. Since greenwashing continues to damage Sri Lankan green market space in various ways, the authorities should establish adequate regulatory measures to prevent greenwashing and reposition the authentic green products within the Sri Lankan green consumers' minds. Also, with the heightening consumer awareness of greenwashing, organizations need to refrain from greenwashing practices to sustain and prosper in a green market.

Keywords: *False Green Claims, False Green Images, Greenwashing, Green Consumers, Sri Lanka*

Influence of Social Media Advertising on Customer's Purchase Intention

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Social media is becoming an inseparable part of people. Organizations increasingly use social media to perform many marketing and advertising activities. Customer decision making process is influenced by organizations using social media advertising (SMA). However, it is a great challenge to the organizations to know how to influence customer purchase intention. Even though studies have been conducted to fill this gap, there are some contradictions of findings in the available literature. Therefore, the current study aims to identify the influence of social media advertising on customer's purchase intention. The conceptual framework was developed based on the extended unified theory of acceptance and use of technology (performance expectancy, hedonic motivation, & habit) along with interactivity and informativeness. Data was collected from 400 respondents via online questionnaire which was valid and reliable. 324 questionnaires were received with the response rate of 81%. Correlation and Multiple regression analysis was performed using IBM's SPSS software to identify the influence of social media advertising on customer's purchase intention. Results indicated performance expectancy, hedonic motivation, interactivity and informativeness features of social media advertising influence customer's purchase intention. Informativeness was the strongest predictor of customer purchase intention and Facebook dominates in social media advertising platforms in Sri Lanka. Further, the present study provides theoretical as well as practical implication on how organizations should design their SMA to influence customer purchase intention. Accordingly, findings reveal marketers who market products targeted to male, young customers and or educated customers, could get desired outcomes by using social media advertising. Findings of the current study contributes to the existing knowledge by empirically supporting usefulness, fun & entertainment, informativeness, and interactivity features of SMA influence customer's purchase intention.

Keywords: *Customer Purchase Intention, Informativeness, Interactivity, Social Media Advertising, Social Media Platforms, UTAUT2*

An Evaluation of E-Government Applications in Sri Lanka

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E-government is the use of ICT and its applications by the government for the provision of information and public services to the people with the purpose of enhancing the efficiency, effectiveness and productivity of the delivery of public services. In such an informative era, countries all around the world are using information technology for their government operations. With that context, the current study has been conducted with the purpose of identifying the level of e-government usage in Sri Lanka. This study has used the UN-ASPA Five Stages of e-government model to analyze the level of e-government in Sri Lanka. 20 websites which represent the state sector organizations have been randomly selected and evaluated during a two months period using observation methods to gather data for this study. The sample represented web sites of state ministries, departments, universities and other several utility services. Each state web site has been evaluated separately using observation methods and marks have been allocated according to a predetermined scale. The observed data has been analyzed descriptively. As per the data analysis 50% were able to categorize under interactive web presence according to the UN-ASPA Five Stages of e-government model. Therefore, it is able to conclude that the level of e-governance usage in state government web sites in Sri Lanka falls into Interactive web presence. This study has some limitations which the future researchers are able to pay attention to. Only 20 state web sites were selected for this study and the sample can be enhanced to have holistic findings of the same study.

Keywords: *E-governance, Governance, Information Technology, State Sector, Web Presence*

Indigenous Knowledge and Sri Lankan Models to Address Global Health Challenges

The theme this year highlights knowledge created in Sri Lanka or derived from indigenous health systems, and models of care that have contributed to face global and local health challenges, including COVID-19 pandemic. How has such knowledge addressed health problems related to maternal and child health, mental health, injuries, emerging infections, neglected tropical diseases, chronic kidney disease of unknown aetiology (CKDu), climate change and environmental and occupational hazards? How have we advanced our understanding and treatment of these and other health problems facing Sri Lanka and the region? The following section contains research findings on areas such as public health models and challenges facing Sri Lanka and the region, facing emerging infections, tropical diseases and health hazards, advances in diagnostics and therapeutics, and challenges and advances in medical education.

Plenary Speech by Professor Kamani Tennekoon

How Indigenous are We?

Dispersal of the Anatomically Modern Humans is assumed to have taken one of two routes out of Africa to populate rest of the world; the Northern route and the Southern coastal "beachcomber" route. It is plausible that Sri Lanka's strategic location in the Indian Ocean made it very attractive for early migrants traversing the beachcomber route to settle down. The land bridge that existed for a long time throughout the last 700,000 years between India and Sri Lanka would have also facilitated movement of people from mainland India via either route. The mitochondrial DNA (mtDNA) which is exclusively maternally inherited is a genetic marker used to identify routes of human migration and population affiliations. Out of Africa mtDNA belonged to L3 macrohaplogroup which then branched to M and N macrohaplogroups. Further divisions that occurred helps to identify geographical affinities of mtDNA haplogroups. Our studies on mtDNA demonstrate presence of Indian (South Asian) and West Eurasian ancestry among contemporary Sri Lankans. The Adivasis (Vedda) who are believed to be descended from "Balangoda Man" have mtDNA lineages that are mostly different from Sinhalese, Sri Lankan Tamils, Muslims, Malays, and Indian Tamils, while some mtDNA shared with these ethnicities occur in varying degrees. While M macrohaplogroup is the predominant type of mtDNA in all the other ethnicities, N macrohaplogroup is predominant among Adivasis. When compared with other ethnicities (i.e., Muslim, Malay, and Indian Tamil) who migrated much later to the country, Sinhalese, Sri Lankan Tamils, and Adivasis have a considerable presence of West Eurasian haplogroups among them, suggesting both Indian and West Eurasian ancestry.

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Advances and Challenges in Diagnostics, Therapeutics and Medical Education

Analysis on *Dashāngalepaya* (An Ayurveda medicinal paste) for Swelling of Joint Disorders : A Review

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Ayurveda mainly use herbal medicines in treating and preventing diseases. Joint disorders like Osteoarthritis (OA), Rheumatoid Arthritis (RA) which can be correlated respectively with 'Sandhigatha vātha' and Āma vātha in Ayurveda are common in adult population today. Pain, swelling, stiffness, reduced range of movement are common signs and symptoms of these disorders. Due to side effects of allopathic treatment, people tend to seek relief from alternative medicines like Ayurveda. *Dashāngalepaya* is a poly herbal Ayurvedic powder (Chūrna) which is used as an external treatment for joint disorders. Study was focused in analyzing pharmacological properties of *Dashāngalepaya* in reducing swelling of joints. Literature survey was conducted using Ayurveda authentic texts, medical books and published Research articles. Joint diseases cannot be cured completely and accumulation of fluids around affected joint cause swelling. *Dashāngalepaya* contains ten herbal ingredients including Albizia lebbeck, Glycyrrhiza glabra, Valeriana wallichi, Pterocarpus santalinus, Cinnamomum verum, Nardostachys jatamansi, Curcuma longa, Berberis aristata, Saussurea lappa, and Vetiveria zizanioides. According to Vruhath Nigantu Rathnākara, *Dashāngalepaya* is indicated for skin disorders by mixing with ghee. But practically this is used as a Poultice (Upanāha sveda) for swollen joints by mixing with juice of Tamarindus indica leaves and heating in moderate heat. Analysis of Rasādi panchakaya (Ayurveda pharmacological properties) showed that among the ten ingredients, 70% was having bitter taste (thiktha rasa) and (90%) with light, rough qualities (laghu, ruksha guna) that help in reducing Kapha dōsha which causes swelling. Hot potency (ushna veerya) also helps in reducing swelling, and pain caused by vātha dōsha. Research article findings showed that most ingredients of *Dashāngalepaya* were having anti-inflammatory properties which help in reducing inflammatory swelling of joints. Clinical studies can be conducted to find therapeutic efficacy of *Dashāngalepaya* in reducing joint swelling. Laboratory investigations can be followed to analyze chemical composition of this valuable medicine.

Keywords: *Dashāngalepaya, Joint Disorders, Poultice, Swelling*

Conceptual Study on Modern Applicability of *Viruddha Ahara* (Incompatible Foods) in Ayurveda WSR to *Charaka* Samhita

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Ayurveda elaborates on five fundamentals in pharmacology, as *Rasa* (taste), *Guna* (physical attributes), *Veerya* (potency), *Vipaka* (outcome of digestion) and *Prabhava* (specific potency) of a *Dravya* (substance). *Dravya* dominant in *Rasa* is termed as *Ahara* (foods) while *Veerya* dominant termed as *Aushadha* (drugs). *Viruddha Ahara* gives rise to various disease conditions. *Charaka Samhita* has described eighteen such incompatibilities related to dietetics in the 26th chapter of Sutrasthana. Modern sciences do not clearly describe food incompatibilities, but Ayurveda gives detailed descriptions tailing them down to its types. Therefore, this study builds a comparison as per the modern view to the types found in Ayurveda. This review aims to critically discuss the *Viruddha Ahara*, to review the diseases caused by incompatibility along with relevant therapeutics to raise social awareness. The study was composed as a literature review. The data relating to *Viruddha Ahara* were collected from *Charaka Samhita*, previous research articles published on databases such as PubMed®, Web of Science, Google Scholar and ResearchGate with the official website of the United States Food and Drugs Administration (FDA). *Acharya Charaka* interprets 18 types of *Viruddhathva* as *Desha*, *Kala*, *Agni*, *Matra*, *Satmya*, *Dosha*, *Samskara* etc. *Charaka Samhita* also discussed the diseases that arise due to incompatibility as *Shandya* (impotency), *Andhya* (blindness), *Veesarpa* (erysipelas), *Unmada* (mental disorders) etc. *Vamana* (emetic therapy), *Virechana* (purgation) and pacification of *Dosha* (body humor) are indicated for their management. According to the results, it is evident that *Acharya Charaka* points out these incompatibilities to highlight the importance of the status of *Ahara* for positive health. Prolonged consumption could result in deadly disorders as mentioned above. The therapeutics eliminate the vitiated *Dosha* brings balance to the body. Therefore, can be concluded that the concept of *Viruddha Ahara* owe higher clinical significance regarding the positive health of the community and can be used to cure various ailments that arise from the false food habits of mankind.

Keywords: *Charaka Samhitha, Foods, Incompatibility, Viruddha Ahara*

Critical Analysis of a Selected Herbal Hair Application Applicable as a Herbal Hair Dye for *Palithya* Relation to Premature Greying of Hair

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Hair plays a significant role to improve the individual identity and body image in physical appearance. Premature greying of hair has become a one of condition which can affect the self-esteem in cosmetic concerns. Thus, Hair dyes have become the main modality of the treatment for after nutritional supplementation. With the development of the technology, using many chemical products for the cosmetic purposes has become a major health risk today. Thus the using of eco-friendly herbal hair dyes will lead to reduce the health risks and cosmetic solution for the premature greying of hair. Therefore, objectives of this study was to critically analyze a selected herbal hair application applicable as an Ayurvedic herbal hair dye for *Palithya* relation to premature greying of hair and to study the pharmacodynamics properties of the drugs of selected hair application. In Ayurveda, premature greying of hair has mentioned as *Palithya* and discussed under the *Kshudra Roga* and *Shiro Roga*. Literature information has gathered from the Authentic Ayurvedic text books, previous research evidences and websites. According to the gathered data, the selected *sheershalepa* (hair application) consisted with Fruit of *Phylanthus emblica*, seeds of *Sesamum indicum*, stamen of *Nelumbo nucifera*, stolon of *Glycyrrhiza glabra* and Bee honey. It has shown the 80% of *PittaDosha shamaka* quality (controlling body heat), 60% of *sheeta veerya* (cooling potency) and all most all drugs containing *Madhurarasa* (Sweet taste) and 60% of drugs has the Guru guna (heaviness) which can control the etiopathogenesis of *Palithya*. Further, these drugs contain antioxidants, minerals and vitamins which give the nourishment by using the *vishada guna* (penetrating quality) of bee honey. By concluding these properties, the selected *sheershalepa* can be used as a hair dye in the *Palithya* or premature greying of hair.

Keywords: *Herbal Hair Dye, Palithya, Premature Greying*

Development of Pasteurized Milk Incorporated with Ginger, Turmeric and Pomegranate Pee Lextracts

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The aim of this study was to develop value added pasteurized milk with *Zingiber officinale* (Ginger), *Curcuma longa* (Turmeric) and *Punica grantum* (Pomegranate) peel extracts with acceptable sensory properties and evaluate proximate composition,physiochemical properties and microbial acceptance. Ethanolic extracts of selected herbal ingredients were incorporated in order to enhance immune responses while providing several health benefits due to active compounds of plant extracts. Inorder to identify active compounds of plant extracts, GCMS analysis was conducted and several pharmacologically important compounds were identified. Best formulation for the product was selected through a sensory evaluation by a 5 point hedonic scale. The formulation of 300 ppm of ginger, 100 ppm of turmeric and 300 ppm of pomegranate was found to be the best formulation from all sensory attributes significantly ($p<0.05$) . Proximate composition, antioxidant activity and gallic acid equivalent phenolic content of milk samples and plant extracts were determined at first days of the shelf life. The total plate count, coliform content and yeast and mold content were evaluated at 1st day, 3rd day and 5th day of storage. Further, the pH and titratable acidity of milk samples were checked every day in shelf life period.When considering physiochemical properties of the final product, antioxidant activity (40.615±0.447) and gallic acid equivalent total phenoli ccontent (0.532±0.004) were significantly higher ($p<0.05$) in the newly developed product. Antimicrobial properties of plant extracts were checked using a garwell diffusion method against *Bacillus subtilis*, *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa* and *Candida albicans*. All 3 extracts have shown inhibition towards selected pathogenic bacteria and fungi.Final product possesses antimicrobial properties, high antioxidant activity and total phenolic content. Thereby, it can be concluded this product has a considerably improved medicinal value than normal milk as it was incorporated with ginger, turmeric and pomegranate peel extracts.

Keywords: *Antimicrobial Activity, Ginger, Milk, Pomegranate, Turmeric*

Evaluating the Long Case Components of Final MBBS Clinical Assessment

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Long case among the different components of the traditional final examination of medical undergraduate has a significant place. The different components to the final year examination in medicine includes Multiple-Choice Questions (MCQ) and Structured Essay Questions (SEQ) that assess theoretical knowledge, Short Cases (SC) and Long Cases (LC) assessing the practical and clinical competency and the Objective Structured Clinical Examination (OSCE) that assess both theory and practical competencies.LC encompass a major section of final MBBS examination in Sri Lanka although it has become less popular in some western countries. Its efficacy compared to the other components of the final examination is not well assessed scientifically. We conducted a pretested (with a pilot study) online questionnaire to assess this as a cross sectional survey. Participants were those who have completed the final MBBS examination within one year (n=201 with a response rate of 52%) to avoid the time-based bias of 'how it felt by the candidates'. The questionnaire compared LC with other different components of the final exam in the first section. The second section was on time allocation for LC and in the third section we questioned how they feel about having an observer during LC.Written exams became the best tool to assess a wide range (breath) of competencies, while short cases became the best tool to assess skills in clinical examination of patients. On time allocation, the majority found that time spent with patient and the time for discussion with examiners is adequate (84% and 82.1% respectively) while a majority perceived time for preparation before presenting the case to examiners as inadequate (90.6%). Having the examiners observe the history taking was considered ineffective by 73.6% of the students and 76.2% stated it increased their level of anxiety. The best examination format to which observing can be applied was chosen as long cases (87.6%).The results showed that the best examination component to assess clinical competency and holistic approach on patient management is LC. Overall, the LC was considered a suitable tool for assessments that had the ability to assess the depth and width of clinical competencies required by medical undergraduates.

Keywords: *Clinical Assessment, Final MBBS, Long Case, Medical, Undergraduate*

Hepatoprotective Effects of Curcumin-Piperin-Nano-Conjugate against Chemically Induced Hepatocellular Carcinomain Rats

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Hepatocellular Carcinoma (HCC) has become a major cancer type in the world with high mortality due to a lack of effective therapies and late diagnosis. Curcumin is the main bioactive compound found in *Curcuma longa* (Turmeric) and has known medicinal properties including anti-carcinogenic effects. Hence, this study was designed to evaluate the hepatoprotective effects of curcumin-piperin-nano-conjugate (CPN) against chemically induced liver cancer in rats. Twenty-four male Wistar rats were divided into four groups including healthy control, HCC control, HCC+CPN low dose and HCC+CPN high dose group. In the HCC group a single intraperitoneal injection of diethylnitrosamine (DEN) at 30 mg kg^{-1} body weight (BW) and thioacetamide (TAA) at 50 mg kg^{-1} BW once in three days were given for seven weeks. Two doses of curcumin (low: 100 mg kg^{-1} BW and high: 200 mg kg^{-1} BW) were gavaged with two HCC groups. Changes in body weights and liver weights, body weight gain (BWG), liver index (LI), gross pathology/histopathology of livers and serum liver enzymes (ALP, AST, ALT) were evaluated after seven weeks. Final body weights and liver weights were not significantly differed from the healthy control group ($p<0.05$). BWG and LI were significantly reduced in HCC+CPN high dose group ($p<0.05$) reflecting the positive effect of high dose CPN. Histopathologically, the HCC group showed large areas of neoplastic hepatocytes nodulation (65% of the liver area). HCC+CPN low dose showed neoplastic nodules in 45% of the liver area. CPN high dose showed neoplastic proliferation only in 25% of the liver area. Moreover, CPN 100 mg kg^{-1} BW dose reduced serum liver enzymes levels indicating a high antioxidation effect. Overall, our results reflect the hepatoprotective effect of new CPN complex against HCC warranting further investigations.

Keywords: *Curcumin, Chemically-induced Liver Cancer, Liver Enzymes, Hepatoprotective Effect*

The Efficacy of the Newly Designed First Page for the Bed Head Ticket Compared to the Conventional First Page

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The medical notes maintained as patient records are called Bed Head Ticket (BHT). The first page in the BHT in Sri Lanka is used for decades unchanged. Many health care workers believe that current first page of BHT has deficiencies. It contains, name, age, sex, address, BHT number, the guardians name and address, ward, admission date and time as the medical information. Authors designed a 'new first page' (NFP) for the BHT to improve the quality and content of information. The Additional medical information included in NFP are: presenting complaint, medical background, allergies, working diagnosis, usual place of living, next of kin, pre morbid activities of daily living and anticipatory care plan.We conducted this audit to assess the benefits of a newly designed first page compared to the conventional one. The NFP was completed in 1638 out of 3657 (44.8%) BHTs during a two-month period in the professorial unit of medicine, National Hospital of Sri Lanka. The reasons given for failure to fill (>55%) the NFP include lack of time and unable to fill this during emergencies on admission. The completed (or partially completed) NFPs were useful during the ward round and various occasions like discussions, referrals, writing diagnosis cards and during the communication with patients and families.After the 2 months use of the NFP the health care team and medical students were given a questionnaire and the responses were analyzed. The data was collected from n=68 respondents: doctors (D) (n=11), nurses (N) (n=10) and medical students (MS) (n=47) in the unit during the 2 months period.NFP was considered beneficial to doctors by 65/68 (95.6%) and by 8/11 (72.7%) doctors, and by all N and MS (100%). It was considered beneficial to patients by 64/68 (94%), and by 7/11 doctors and by 9/10 nurses. It was considered beneficial to carers by 52/68 (76), and by 7/11 doctors and by 6/10 nurses. 60/68 (88%), (D=3/11, N=10/10) thought it is beneficial to nurses.NFP may be a useful instrument to improve quality of care as agreed by majority of health care workers in the medical professorial unit, NHSL and final year medical students involved in this study. Further study with the participation of medical officers OPD and ETU, admitting officers, judicial medical officers (JMO) is recommended to improve the validity.

Keywords: *Bead Head Ticket, First Page, Medical Records, Patient Admission, Sri Lanka*

Emerging Infections, Tropical Diseases and Health Hazards

Health Impacts of Gem Mining and Related Industrial Work in Sri Lanka : A Systematic Review

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Gem mining and Gem Industry is a key feature in Rathnapura District, Sabaragamuwa province. The industry has definite benefits but not without adverse effects to the environment, agriculture, human health and cities, villages and roads. However, there are not enough studies conducted to identify the hazards associated with gem mining. We planned this systematic review to help fill this vacuum. It is aimed at identifying the effects on human health. We searched the PubMed, Google Scholar and ResearchGate data bases for the articles published on health hazards of gem mining in Sri Lanka. The selection criteria used for selection of articles are as follows: Inclusion criteria, 'articles describing the health hazards of gem mining' and 'articles Published after 2010 up to date'; Exclusion criteria: 'Articles published before 2010' and 'Those articles published coal mining and other mining work but not gem mining', 'Articles published on mining work in countries other than Sri Lanka'. At the end of the search, filter and removal of duplicates, we collected four articles that met our inclusion criteria. Study of these articles led toidentify the common health hazards of gem mining such as; physical injuries, gaseous hazards, respiratory effects, heavy metal poisoning, dehydration, dermatoses, infections, snake bites, flooding and drowning, increase in mosquito borne diseases, psychological effects, heat effects, effects on vision and hearing and joint diseases. The whole process in gem industry carries a range of risks that includes health hazards while working in pits, damage to environment and roads from pits, open unclosed pits leading to drowning, injuries and becoming mosquito breeding sites and inhalations of dust during gem cutting. It is important to conduct scientific studies to further identify, minimize hazards, educate people and lay out appropriate legislation on the subject.

Keywords: *Gem Mining, Health Impacts, Ratnapura, Sri Lanka*

Literature Review of *AJITA AGADA* for Poisoning Conditions

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Acute poisoning is one of the major clinical problems prevailing in Sri Lanka. This study was done to address the above problem with *Ayurveada* perspective. *Agada Tantra* is the clinical speciality which can be compared with modern toxicology. In *Agada Tantra*, various formulations for poisoning (*Visa*) conditions are described. These are known as *Agada Kalpa* namely. *Ajita Agada* is such a preparation found in *Ayurveda* Texts. This study was aimed at reviewing *Ajita Agada* along with the analysis of pharmacological properties of its ingredients and their therapeutic contribution to understand its action collectively. The study was done by referring peer-reviewed published articles through credible search engines and *Ayurveda* authentic texts. Pharmacodynamic analysis on both *Ayurveda* and modern perspective was done to understand the mode of the action of the said preparation collectively. Prominent pharmacodynamic properties being similar with the properties of poisons as per the *Ayurveda* context, *Ajita Agada* acts as an antidote by interfering the spreading of the poison and avoiding tissue damage leading organ destruction. As *Ajita Agada* is indicated for all kind of poisonings in references and poison like properties, there is a possibility to be utilized as an emergency treatment modality in critical care for acute poisonings.

Keywords: *Acute Poisonings, Agada Tantra, Ayurveda Toxicology*

Systemic Manifestations and Long-term Effects of Hump-nosed Pit Viper (*Hypnale* spp.) Envenoming in Sri Lanka: Need of Efficacious Antivenom

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Hump-nosed vipers of the genus *Hypnale* are the commonest cause of venomous snakebites in Sri Lanka (22-77%) and they frequently cause local effects. No antivenom is currently available for their bites in Sri Lanka. Their envenoming also causes systemic manifestations which are sometimes fatal. Therefore, World Health Organization has categorized *H. hypnale* under category I of medical importance snake that may require antivenom. The objectives of this study were to describe systemic manifestations and long-term effects of hump-nosed viper bites. A prospective cross-sectional study was conducted for patients admitted with hump-nosed viper bites to Teaching Hospital, Ratnapura. Data collection was done for 5.5 years commencing from January 2015 using an interviewer-administered questionnaire. Patients were followed up for 1 year and statistical analysis was done using the SPSS-21st version. All hump-nosed viper bites were 683 (36%) and local effects were 642 (94%). Systemic manifestations were observed in 89 (13%) from which acute kidney injury in 77 (11.3%), thrombocytopenia in 72 (10.5%), thrombotic microangiopathy in 52 (7.6%), hemolytic uremic syndrome in 47 (6.9%), coagulopathy in 46 (6.7%), microangiopathic hemolysis in 42 (6%), haematuria in 36 (5.3%), ECG changes in 13 (1.9%), systemic bleeding in 10 (1.5%) and thrombotic thrombocytopenic purpura in 2 (0.3%). Each 1 (0.1%) developed generalized ecchymoses, Kounis syndrome and ischemic stroke. Eight (1.2%) patients died and 40 (5.8%) developed long-term effects such as chronic kidney disease (CKD)-22 (3%), chronic wounds-5 (0.7%), digital amputation-4 (0.6%), fasciotomy-3 (0.4%), skin contractures-2 (0.3%) and each 1 (0.1%)-generalized ecchymoses and ischemic stroke. The most prominent laboratory finding was the eosinophilia (167;24.5%). Treatment options were haemodidlysis-47 (6%), therapeutic plasma exchange-21 (3%) and administration of fresh frozen plasma-29 (4.2%). Hump-nosed viper bites cause frequently local effects (>90%) and less frequently (13%) systemic effects. CKD is the commonest long-term effect for which regular renal replacement therapy is needed.

Keywords: *Hump-nosed Viper, Hypnale spp., Long-term Effects, Snakebites, Sri Lanka*

The First Identification of Multidrug Resistant Uropathogenic *Enterobacter hormaechei* Subsp. *Steigerwaltii* St93 from Sri Lanka

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The spread of multidrug resistant *Enterobacteriaceae* strains resulting in treatment failure and increased mortality has become a global health issue. Of these, members of *Enterobacter cloacae* complex are of major concern due to their association with transferable multidrug resistance and the establishment of successful clones. Such strains pose a potential threat to hospitals as they are known to cause hospital outbreaks. The data regarding antimicrobial resistance (AMR) and transmission in pathogenic bacteria are important to decide infection prevention and control measures locally and internationally. This paper describes the first identification of carbapenem-resistant *Enterobacter hormaechei* subsp. *steigerwaltii* ST93 in Sri Lanka. One *Enterobacter cloacae* strain (ECC) from a collection of ninety-four uropathogenic *Enterobactericeae* isolated from hospital-acquired urinary tract infections (HA-UTI) from Sri Jayewardenepura General Hospital, Sri Lanka was analysed using genomic sequencing and comparative genomics. Seventeen AMR genes that confer co-resistance for several antibiotic classes such as β-lactams, carbapenems, aminoglycosides, fosfomycins, macrolides, sulphonamides, trimethoprim, phenicols and tetracyclines were identified. Coexistence of two types of carbapenem resistance genes ($bla_{\text{NDM-4}}$ and $bla_{\text{OXA-181}}$) was a significant finding. Virulence genes coding for several important functional proteins were identified. Some of these include *mrk*genecluster that encodes type 2 fimbriaethat are associated with biofilm formation and Type VI secretion systems loci (T6SS)which confers the ability to survive in a range of environments. The isolate did not carry any plasmids. However, several mobile genetic elements (IS*Ecp1*, IS26-IS26 composite transposon and IS5) were identified flanking AMR genes such as $bla_{\text{CTX-M-15}}$, $bla_{\text{NDM-4}}$ and *ble* gene cluster and *aac*(6$^{'}$)-*Ib-cr*, $bla_{\text{OXA-1}}$, catB3 gene cluster that contribute to the horizontal transfer of these genes. This study provides important information on the development and dissemination of genes coding for antimicrobial resistance and adds to the currently scarce data on AMR in Sri Lanka.

Keywords: *Enterobacter Cloacae Complex, Multi Drug Resistance, Antimicrobial Resistance Genes, Virulence Genes, Mobile Genetic Elements*

Public Health Models and Challenges Facing Sri Lanka

Towards Developing a Model to Sustain Rehabilitation and Intervention Services for Children during the Pandemic

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The COVID 19 pandemic resulted in social restrictions adversely impacting most health services. Children requiring regular clinical services were denied access to the clinics. Many clinicians faced a dilemma trying to sustain the services for children with developmental needs and disabilities. Interventions for such conditions are time limited and crucial due to a window of opportunity depending on the neural plasticity of the developing brain. Therefore following urgent consultation of team members tele health services based on online platforms were designed. Seventy five children with various developmental needs including cerebral palsy, Down syndrome etc. and at risk neonates received the service during first four weeks of the pandemic in our centre. Thirty two cross referrals were made among the members of multidisciplinary team to maximise their needs. Both synchronous (live) and asynchronous sessions were offered. Many service providers reported that the parents expressed satisfaction during the consultations. This preliminary model is optimistic with successfully sustaining rehabilitation and early intervention services during the pandemic and reaching many families despite the barriers.

Keywords: *Children with Disability, Developmental Delay, Early Interventions, Telehealth*

Energy Availability of Sport Sciences and Physical Education Undergraduates in Sri Lanka

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This research aims to evaluate the energy availability of the Sport Sciences and Physical Education (SSPE) undergraduates in Sri Lanka. Energy availability is the amount of energy remaining from dietary intake after adjusting for energy expended for physical exercise and the metabolic processes related to the fat-free mass of the body. One hundred and one (n= 101) volunteer SSPE undergraduates (aged 20 to 23 years) participated in the study. Body mass (kg) and fat-free mass (FFM) (kg) was measured using the Bioelectrical Impedance Analyzer. The three-day food diary method was used to calculate the mean energy intake per day using a food composition database. The exercise energy expenditure (MET-minutes/week) was computed by the International Physical Activity Questionnaire (IPAQ) (Long version) and converted to the kcal/day. The threshold of low energy availability (LEA) was considered as $<$30 kcal/kg FFM for both males and females, and those who scored $<$30 kcal/kg FFM were considered as "at risk of LEA," and those who scored $\geq$30 kcal/kg FFM were considered as "not at risk of LEA." According to the results, most male undergraduates (65%) are at risk of LEA of (22.6 ± 4.4 kcal/kg.FFM), while most female undergraduates (66%) are not at risk of LEA (38.3 ± 7.9 kcal/kg.FFM). However, approximately half of the SSPE undergraduates were at risk of LEA (50%) is a significant finding of this research. The low energy intake is the prime factor of the LEA. Neither SSPE undergraduates at risk of LEA nor the undergraduates not at risk of LEA met the recommendation for carbohydrate intake (6-10 g/kg body weight /day) and protein intake (0.2 – 1.7 g/kg body weight /day). Therefore, further investigations and preventive measures, and strategies are needed to avoid the LEA of this population.

Keywords: *Energy Availability, Low Energy Availability, Fat-free Mass, Macro-nutrient, Energy Expenditure*

Establishing Trained Palliative Care Teams to initiate Palliative Care Services in Referral Hospitals in Sri Lanka : A Pilot Programme

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Palliative care is the prevention and relief of suffering experienced by adults and children living with life limiting illnesses and their families. In view of the exponential rise in chronic non-communicable diseases in Sri Lanka, palliative care remains a major gap in the current healthcare system. Appropriate palliative care approach could save costs and improve the quality of life of patients who could be managed at their own community. Palliative and End of Life Care Task Force is an expert committee established under the Sri Lanka Medical Association which comprises multidisciplinary healthcare professionals and civil society. As palliative care is an interdisciplinary effort, establishing trained palliative care teams in the referral hospitals is crucial in initiating and establishing palliative care services in the country. A pilot programme was planned in Western province to train hospital palliative care teams in alignment with the National Strategic framework on Palliative care. A situational analysis was done. A workshop was held to develop a curriculum to train healthcare staff on palliative care which was followed by a two-day training workshop to build teams and train them to function in those referral hospitals as palliative care teams. Six hospital teams of 8-10 healthcare professionals from all categories attended the workshop. Training programme consisted of basic concepts of palliative care, guidance to common symptom control, soft skills, hands-on skills and case-based discussions. All topics were delivered by experts in relevant fields. All participants were satisfied about the programme content and arrangements with suggestions on improvements. All trained palliative care teams were functional in the hospitals following the programme. This pilot training programme has been successful in establishing trained palliative care teams in selected hospitals in Western province. Such teams might be imperative to initiate and continue palliative care services in referral level hospitals in Sri Lanka.

Keywords: *Healthcare Professionals, Palliative Care, Referral Hospitals, Team Building, Training*

Evolving Sri Lankan Model for Delivery of Palliative Care: 2010-2019

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Sustainable model for delivery of palliative care services is a timely need with increasing incidence of life-threatening illnesses. Therefore, the objective of this study was to conduct a desk review to describe the process of evolving model for delivery of palliative care in Sri Lanka during the period of 2010 - 2019. The interventions carried out during this period were grouped as (i) policy (ii) capacity building (iii) drug availability & (iv) initiating service delivery interventions. Palliative care was included in the National Health Policy for year 2016–2025 and several sectoral policies including policy on Chronic Non-Communicable Diseases (2010), Cancers (2015), Elderly Health (2017). Also, palliative care has been identified at the Health Master Plan 2016–2025. Capacity building programmes on palliative care were incorporated to basic, in-service, post basic and post graduate programmes. Commencement of Post Graduate Diploma in Palliative Medicine, development of curricula of post basic diploma in palliative nursing, inclusion of palliative care module to the post basic training programme on public health nursing officers were some of the interventions. Ensuring availability of all oral morphine formulations throughout the year with inclusion of liquid morphine and allowing prescription of oral morphine for one-month duration were some of the interventions for improving availability of drugs for palliative care. Also, lower dosage forms of fentanyl preparations were introduced. Pain management guidelines and palliative care guide books were launched. Commencement of palliative care consult services at selected tertiary and secondary care hospitals and commencement of home-based care services by public health nursing officers and volunteers were some of the service delivery interventions.These interventions paved the way for developing 5-year national strategic framework on palliative care development for year 2019 - 2023 and the effect of these interventions would contribute for evolving sustainable palliative care service delivery model in Sri Lanka.

Keywords: *Palliative Care, Service Delivery Model*

Identifying Risk Factors of Total Cholesterol Level of Patients in Kegalle District, Sri Lanka

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This study is aimed to investigate the association between the total cholesterol level and some risk factors, such as Age, BMI, exercise hours per week, Gender, Smoking, Diabetes, High blood pressure, Family history and Food habits. The data was obtained from randomly selected 207 patients with high cholesterol in Kegalle district, Sri Lanka in 2020. A multiple linear regression model has been used to determine the risk factors associated with the total cholesterol level of the patients, where, the total cholesterol level is treated as a response variable and the risk factors are considered as explanatory variables. More specifically, a stepwise model selection technique has been applied to identify the best fitting model. Further, a diagnostic checking is done for the fitted best regression model. Results reveal that age, BMI, exercise hours per week, smoking, diabetes and family history have become significant risk factors for the total cholesterol level. Also these factors have shown a positive association with the total cholesterol level while the exercise hours per week have shown a negative association.

Keywords: *Total Cholesterol Level, Multiple Linear Regression, Stepwise Regression Method*

Envisioning the Future of Social Sciences and Humanities

The global pandemic changed human life forever. Its waves swept across Higher Education, and the Social Sciences and Humanities also had to suddenly reshape their method of delivery to fit into the new contingent situation. The need for moving onto the virtual arena became ever so essential, given the fact that humanity struggled to move beyond its familiar physical landscape. The changes that these disciplines were expected to introduce to their content and delivery in the future became a reality overnight. Some were well prepared for this, but some were not. It was a sudden leap into the future, and there are so many success stories that need to be shared globally. Yet, there are stories in which students, teachers, and researchers showed real courage in overcoming certain challenges, virtual and otherwise, in this unexpected turn of events. Everyone had to rethink the strategies, content, evaluations, and methodologies involved in the face of this unforeseen challenge. Based on the nonconforming experience, this section opens a broader dialogue on visualizing the future of the Social Sciences and Humanities and the potential pedagogical, ontological, methodological, and theoretical challenges that may yet arise in the twenty-first century.

Plenary Speech by Professor Liyanage Amarakeerthi

Making Closer Connections among Different Branches of Human Knowledge: A Partial Vision for the Future

The humanities and the social sciences are regularly demanded to justify their existence forcing, in turn, the scholars in those subjects to justify themselves. In the face of these challenges, some subjects, particularly in the humanities, tend to fade away as lackluster or less important fields in the academia. Even the subjects whose existence may not have been threatened as yet are still demanded to come up with practical applications in everyday life. Thus, one sees sociology or psychology turning more and more 'practical' trying to produce answers for everyday problems of our times such as alcoholism, increasing of divorce, or stress at work places. There is nothing inherently wrong with different branches of human knowledge attempting to be useful, and, arguably, knowledge in the first place appeared through such practical circumstances. There is a fundamental error, however, in overdetermining the 'practical use' of human knowledge. Each of human subject at a deeper level lends itself to reflection, musing, imagination, and asking big questions about human existence that lie beyond the everyday.

I aim to propose in this speech several approaches through which the humanities and the social sciences can be much more integrated to a holistic system of knowledge and education. One of the ways to do so, I believe is to redefine the boundaries between subjects, and the idea of liberal arts provides an opening for such a move. Liberal arts is broader than the humanities and social sciences, in the sense they are used in Sri Lanka. In its classical sense, the humanities, social sciences, and natural sciences are included in liberal arts, and within it, even natural sciences have a philosophical existence rather than merely a practical one.

When one sees these different branches of human knowledge as an integrated whole, one can imagine an alternative future for all subjects, particularly the humanities and the social sciences. Taking a cue from the work of scholars such as Antonia Damasio (Descartes' Error) and Robert Sapolsky (Behave) I argue that the boundaries between humanities and natural sciences, for example, are much more porous than we usually admit. Damasio has demonstrated that 'rational thinking' and 'feeling' in human beings are mutually interdependent, and rational and abstract thought support each other within the human brain and nerves system. Sapolsky has shown that some key concepts such as love, anger, disgust, and so on that are normally taken to be the subjects of the humanities cannot be explained without considering the chemical reactions of

human body. Thus, one way to reconnect the branches of knowledge that have detached each other with the advent of modernity, i.e. the enlightenment rationality, is to see what we in the humanities can learn from natural sciences. There have some groundbreaking studies already in that area and it is worthwhile, this speech suggests, to make an effort to learn from them.

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E-Learning in the Era of Pandemic

A Study of Reliability and Validity of Online Assessments During The Covid 19 Pandemic

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An unforeseen demand for using online platforms for education skyrocketed during the COVID 19 pandemic. This was unprecedented and therefore, has posed a threat to the education system and everything it entailed. This has been particularly true when it comes to testing and evaluation in the ESL classroom. Traditional ESL testing and evaluation methods such as examination papers, assignments, listening and speech tests need to be adapted, if not changed to suit the needs of the current pandemic ridden country. Moreover, mere adaptation of methodologies and material would not suffice to remedy the situation as the teachers' preparedness and their grasp of the relevant technologies have also become deciding factors of a successful testing and evaluation process. A noteworthy fact is that even if these aforesaid methods have been changed/adapted accordingly, their reliability, validity and practicality has still remained problematic. The online space has allowed students to perform certain acts of resistance or noncompliance when it comes to these testing/ evaluation methods. The ESL students would resort to measures such as copying off the internet, using software to translate their ideas from L1, having others face examinations in their stead, and turning speech tests into mere reading activities. Undoubtedly, this has become a problem that ESL teacher could not ignore. This study intended to identify and address the underlying factors that adversely affect the reliability, validity and practicality of ESL testing and evaluation methods used on online platforms. To understand this situation better, the study drew from the works of David Nunan and James Brown which provided the basis of the theoretical framework. The study made use of data gathered from formal interviews with 10 ESL university teachers, classroom observations and student feedback, and was qualitative in nature. Based on the findings, it can be concluded that these student acts are reflective of their resistance and it can also be seen as different ways in which they negotiate with their changing realities in the education system.

Keywords: *Online Assessments, Reliability, Validity, Practicality*

An Analysis of the Issues Faced by Local Chinese Language Teachers in Online Chinese Teaching During the COVID – 19 Pandemic Situation in Sri Lanka

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The Covid-19 epidemic has greatly influenced on teaching Chinese language, and it has also brought out great challenges to Chinese language learners and teachers who are engaged in teaching Chinese as a foreign language all over the word. In order to ensure the quality of Chinese teaching to the students, teachers adjust their teaching concepts and actively carry out online teaching, taking out all efforts to ensure the quality of Chinese teaching for Sri Lankan students, and are using diversified network resources and teaching platforms to fully respond to this battle of Chinese learning. It is undeniable that there are multi-problems in Chinese language teaching and learning in the emerging model of online teaching. A single online teaching model wouldn't be able to meet the needs of teaching Chinese as a foreign language. Online teaching requires a comprehensive use of multiple methods, interaction and collaboration can ensure the quality of teaching. Author found that some College teachers strive to diversify teaching methods and ideas. Some teachers are carefully prepared and implement weekly teaching in accordance with the teaching idea of "discovering students' issues—hypothetical analysis—design—implementation—summary"; some teachers use "mouse learning + online synchronous lectures + homework" teaching mode combined with evaluation and reform; some teachers adopt the interactive teaching mode of "online teaching resources ([cn]) + online Q&A + WhatsApp message exchange". In this research, author combines his own teaching practice and conducts the focus-group interview survey, questionnaire survey and online Chinese language class recordings observation to gather data and analyze the issues that teachers face in online Chinese Teaching under the epidemic situation in Sri Lanka and the author has given some constructive answers, countermeasures to solve these issues using his own teaching practice.

Keywords: *Issues, Local Chinese Language Teachers, Online Chinese Teaching*

E-Class Diary as an Integrated Activity for Continuing Writing Skills in ESL Classes Through Padlet During Covid-19

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This research aimed at implementing e-class Diary writing through Padlet as a medium to continue writing skills of the tertiary level students. The objective was to explore the views of students and teachers on the applicability of Padlet and e-class Diary in language classes as an integrated tool to develop language learners' writing skills during the period of Covid 19 in a virtual classroom. A random sampling was adapted considering 35 undergraduates from English Intensive program in the Faculty of Management and Finance, University of Ruhuna. They were taken as the study participants from a population of 400 undergraduates. For analysis purposes, five e-class diaries were collected for three months' period during the lectures that were conducted two hours per week. In order to obtain the perceptions of participants towards their e-class Diary with the innovative web tool Padlet, 5 Zoom focus group discussions were conducted. The qualitative data gathered through focus group discussions were transcribed and analysed using thematic analysis. The study reported several strengths which may promote the implementation of e-class Diary with the use of Padlet in language education contexts. The results of the research showed that there were improvements on the students' writing skills in different aspects, namely vocabulary, language use, and grammar. In addition, the observations of the researchers revealed that continuation of writing the e-class Diary led the students to move towards digital medium such as Google translator, e-dictionaries etc. To sum up, this study attempted to enrich virtual language teaching classes by implementing Diary writing with Padlet as an integrated activity for writing skill, and to pave the way for further studies that foster application of Web 2.0 tools in language education contexts. Therefore, the hypothesis of "maintaining an e-class Diary can improve the writing skills of tertiary level students" is accepted.

Keywords: *E-class Diary, Padlet, Writing Skills, Collaborative Learning, Covid-19*

Parent's Perceptions towards E-Learning in Covid-19 Pandemic in Sri Lanka

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Due to the threat of its influence on several segments, COVID-19 has turned into a pandemic in March 2020 and it directly impacted the growth of the economy, agriculture, manufacturing, tourism, and education. Further, the pandemic has enforced the schools to the comportment of the non – physical education and e-learning has been selected as the component. Conversely, parents as persuasive supporters for students are impervious to technology due to certain reasons. The study explored the parents' perception of E-Learning through driver, satisfaction, barrier factor. 300 participants were asked regarding this issue by using a web-based survey and 300 questionnaires were delivered randomly to parents of children in elementary, junior high, and senior high schools. The research negated the participants' demographic characteristics as the study only emphasized the parents' perception generally. The questionnaire was graded on a Likert scale of 1 to 5, with responses ranging from strongly disagree to strongly agree. The data was analyzed using the quantitative technique and primary data was given online directly to all respondents. Findings specified that certain barriers in implementing E-Learning during the COVID-19 pandemics, such as the inability to use technology, digital devices ownership, poor internet connection, issues in electricity, the absence of a mentor, and lack of technology skills for children. Students claimed that a corporate classroom learning approach was more realistic and allowed them to interact with teachers and classmates more actively. Though E-Learning has become a popular component during the COVID-19 pandemic for schools and universities, there were several holes in implementing E-Learning in Sri Lanka, especially from the parents' perspective. Further, traditional learning methods were preferred by the parents.

Keywords: *COVID-19 Pandemic, E-Learning, Parents' Perception, Sri Lanka*

Study the Effort of Adopting to Online Learning in State Universities during the Covid-19 Pandemic in Sri Lanka

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Online learning can be regarded as the panacea in the time of Covid-19 pandemic. Education and health are the core drivers of sustaining any economy. A country should take measurements to keep health and education sectors sustained regardless of any adverse situation. When the Covid-19 crisis defeated everything, several sectors were able to absorb the challenges thanks to the online system. Education sector can be regarded as one of the sectors which adopted to the online system very soon. This study attempts to provide insights to study the effort of adopting to online learning in state universities during the Covid-19 pandemic in Sri Lanka. The current study followed the case study approach. Accordingly Sabaragamuwa University of Sri Lanka (SUSL) was selected to gather some data for this study. This study will provide a better understanding of the online learning effort of state sector universities in this pandemic situation. As this is a case study, there is a limitation to generalize the outcomes of this study. Around 100 questionnaires were sent to the students and another set of questionnaires were discussed in two focus group discussions. Convenience sampling technique has been used to select the sample and gathered data have been analysed using the mixed method and presented descriptively. The calculations and percentages have been analysed with the help of MS Excel. The results of the data revealed several information related to the online adoption effort of SUSL in terms of lectures, attendance, examinations, performance, students' preferences, perceptions on e-learning, issues faced during online mode, online assessment methods etc. This study is most relevant for the academics as it facilitates them in gaining a better understanding of the students' opinions towards online learning in this pandemic situation and identifying their concerns related to e-learning.

Keywords: *Covid-19, Online Learning, Postgraduates, LMS*

The Impact of Computer Assisted Language Learning in Learner Psychology During Covid-19 Global Pandemic: A Study with Reference to The Attitudes and Motivation Among Sri Lankan Intermediate Learners of English as a Second Language

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The continuation of education has become one of the major concerns during the current global pandemic of COVID-19. Although, Computer Assisted Language Learning (CALL) is a relatively new concept to school education, Sri Lanka has now joined the global trend of utilising CALL to teach English as a Second Language (ESL) for the learners of different proficiency levels. Yet, it is also noteworthy that the sudden shift in language teaching and learning has a great impact on learner psychology. Learners' affective cognitive factors, attitudes, their motivation, their personality, and time are few aspects that can be interrogated when analysing learner psychology, with the introduction of CALL. Therefore, this study primarily aims to identify whether CALL has a positive impact on Sri Lankan ESL learner psychology, focusing on two main psychological factors: attitudes and motivation. To gather the primary data of the study, online questionnaires, investigating learner attitudes and motivation regarding CALL, were distributed among 50 Grade 11 intermediate students from Kandy (25) and Gampaha (25) districts. Ten participants from each district were randomly selected to conduct semi-structured interviews; Google Sheets and content analysis were used to analyse the collected data quantitatively and qualitatively. The analysed data proved that the learners identify comparatively more negative aspects of CALL than with the traditional language teaching, as the practice of CALL is still new to Sri Lankan ESL learners. However, it was also revealed that the motivational aspect among learners when learning ESL has been considerably increased with the current use of CALL. The study similarly disclosed that the learners have positive outlook towards the future of CALL and their need for innovative methods of CALL usage in language classrooms.

Keywords: *Attitudes, Computer Assisted Language Learning, COVID-19 Global Pandemic, Motivation, Sri Lankan Learners of English as a Second Language*

Economics

Decentralization of Power and Its Impact on Regional Development and Rural Development in Sri Lanka: A Case Study of Sabaragamuwa Provincial Council

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Since the independence Sri Lanka has been concentrated on decentralization of power with different intentions. Particularly, as a solution to the ethnic conflict, ensure the public participation at the local level, and promote regional development and rural development. Provincial Council System (PCS) was set up with these intentions in 1988 under the 13th Amendment to the 1978 Constitution of Sri Lanka, and powers were decentralized to provincial councils, and thereby it was expected regional development and rural development. However, the expectation was not attained due to certain reasons in general, Sabaragamuwa province in particularly. Therefore, the study focused to explore the role played by the Sabaragamuwa Provincial Council (SPC) in terms of regional development and rural development. In line with this, following are the specific objectives; to identify the regional development and rural development disparities within the Sabaragamuwa province and to analysis the different problems and challenges faced by SPC while implementing the regional development and rural development policies. The study was based on both qualitative and quantitative research methods. The Qualitative and quantitative data were gathered by using primary and secondary sources. Primary data were collected through structured questionnaire, semi-structured interviews, focus group discussion and observation. The study sample was consisted of 100 respondents. Beside that content analysis was employed to gather secondary data such as published books, research reports, symposia proceedings, journal and newspaper articles and internet. To analyse quantitative data statistical method was used with SPSS. The discourse analysis was used to analyse the qualitative data, and they were presented using texts, tables, chats and figures. The study found that absence of systematic decentralization mechanism has made huge regional development and ruler development disparity in Sabaragamuwa province. Imbalanced development, disparity in resource allocation, unavailability of effective and efficient service providers, asymmetrical priority in development and severe financial crisis became a significant factor for continuation of regional development and ruler development disparity in Sabaragamuwa province. Additionally, lack of powers of SPC, financial inadequacy, limited revenue sources, high degree of central government interference in making decision on development, lack of institutional capacity, top-down regional development and limited resource allocation are also significant barriers to attain regional development and rural development goals of Sabaragamuwa province. For the improvement of regional development and ruler development goals of Sabaragamuwa province, the study recommends provide enough power for SPC, decrease central government interference in making decision on development, introduce new revenue sources, improve the institutional capacity, mobilizing public to participate in development activities, introduce systematic mechanism to equal resource allocation in the area and find out alternative service providers.

Keywords: *Decentralization, Public Participation, Regional Development*

Gig Economy and the Labour Law of Sri Lanka: A Proposal for a Safety Net for Workers

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Gig economy is sometimes referred to as the sharing economy which is a market based on a fixed-term contract or paid per project or online marketplace. Workers ranging from traditional independent contractors to freelancers or part timers who work selected hours in a day, are the stakeholders of a gig economy. Uber, Lyft and Pickme are the most frequently used platforms that drives the gig economy in Sri Lanka. This novel penetration has overturned the behaviour of the labour market that demands for amends in the legal framework. Although gig economy has its merits the labour law in Sri Lanka does not protect the adverse effects of it. Therefore, it is required to address the problem on how Sri Lankan labour law framework be reformed to cater the demands of the gig economy in way that protects the workers in it. Black letter approach in law, international and comparative research methodology and the systematic literature review are the main methodologies adopted in this research. Primary sources would be the Constitution, enactments, case laws and international standards while books, conference proceedings, peer-reviewed journal articles would be secondary sources. It is analysed how the workers of the gig economy be considered as employees/ independent contractors within the legal framework and how the law needs reformation based on the international experience. The recommendations are followed by the analysis on how the law and policy needs to be changed in order to maintain a safety net for workers who engage in the gig economy. Recommendations are specially focused on the contract of employment, welfare, compensation and health and safety mechanisms with regard to workers of gig economy.

Keywords: *Gig-economy, Reformation of Labour Law, Protecting Workers, Welfare, Working Environment*

New Global Challenges on International Maritime Law

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Maritime law, also known as admiralty law, is a body of laws, rules, and treaties that govern private maritime business and other nautical matters, such as shipping or offences occurring in clear water. International rules governing the utilization of oceans and seas are called the Law of the Sea. The primary focus of this research was to examine international maritime law within a global framework. Accordingly, the primary objective of this research is to identify the latest challenges to international maritime law. The research problem is identifying the major issues in the international maritime law?. The methodology is based on qualitative analysis of secondary data. Threats are identified as being addressed globally through international legal frameworks. The International Maritime Organization is a leader in international efforts to ensure maritime safety. Laws can be formulated with foresight, but shortcomings in their implementation will always be present due to a variety of pragmatic challenges and complexities. The same applies for the enforcement of international maritime lawLOnternational maritime law covers law enforcement, poor security, socio-political instability, etc. to carry out various offences in international waters such as piracy, armed robbery at sea, violence at sea, corruption, illegal fishing, smuggling, etc. In order to resolve these problems and make reparation to the aggrieved parties, interstate cooperation and fair enforcement are needed. Unfortunately, however, States do not co-operate most of the time and justice in maritime law is a mirage.

Keywords: *Maritime law, Global Challenges, Maritime Organization*

The Influence of Central Government Debt on Inflation Rate in the Sri Lankan Economy

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In general, one of the main purposes in most economies is a high economic development of stable or low inflation. Therefore, monetary establishments in countries implement monetary policies to control and maintain inflation at a desirable level. Sri Lanka has undergone a public debt crisis and it is highly impacts the budget deficit over the past years. The level of high inflation and public debt resulted in harmful effects on the Sri Lankan economy. The relationship between government debt and inflation is not much explored in Sri Lanka. Hence, this research strives to analyze the impact of central government debt on inflation using econometric techniques. This study adopted the Keynesian Theory of Public Debt and the Quantity Theory of Money as the theoretical framework. Time series data from 1978 to 2019 was used for the analysis. The study adopted Augmented Dickey-Fuller (ADF), Auto-Regressive Distributed Lag (ARDL) and Error Correction Model (ECM) tests to check the Stationarity, Long-run and Short-run relationships respectively. Inflation is the dependent variable and public debt, GDP, exchange rate, interest rate, savings, trade balance and trade openness are the independent variables used in this study. According to the test findings, all the variables are stationary; and there is an insignificant and significant positive impact on inflation in the long-run and short-run respectively, while other variables also have an impact on inflation. Hence, this study confirms that a 1% increase in central government debt will raise inflation by 376% in the short run in Sri Lanka. The study confirms the positive contribution of the public debt to enhance inflation in Sri Lanka. Hence, it is recommended that public debt be well managed and should invest in viable projects which lead to earning higher returns; maintaining price stability and accelerate the economic growth in Sri Lanka.

Keywords: *Central Government Debt, Economic Growth, Inflation, Savings, Trade Openness*

English Language Teaching

A Need Analysis Approach: An Investigation of Needs in an English for Specific Context

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Need analysis which is also termed as "need assessment" provides an insight into the beliefs, opinions and views of the learners and teachers. Moreover, a need analysis helps in making a language program more attuned to the needs of the learners since it collects and assesses the learning needs of the learners. On the other hand, it can also help in establishing the ownership of a change and innovation among the teachers because it is finally a response at these two levels of teachers and learners. A need assessment always aids to determine the success or the failure of a curriculum with regarding to its existing or revised version. It is accepted that when the curriculum content, materials, and teaching approaches match learners perceived and actual needs, learners' motivation and success are enhanced in the learning process. Thus, conducting a need analysis based on the curriculum or the syllabus that has been taught is necessary in order to analyze the successiveness and the failure of the course as well as to assess whether the learning needs have been met. This paper aims at investigating and determining the effectiveness of the ESP course content and identify the perceptions of students towards the course content. The sample of the study consisted of 30 ESL students who were following the ESP course English for Film and Television Studies. The study employed a combination of two approaches where both quantitative and qualitative data was gathered. Quantitative data was gathered through administering a questionnaire which consisted of both open and close ended questions while qualitative data was gathered through semi structured interviews. The findings of the study suggested that there are some gaps existing between the demanding learning needs and the needs that are covered by the syllabus. Incorporation of activities extensively based on all the four skills, types of classroom activities and also types of lessons to be incorporated in order to provision the learning needs of students were among the major findings of the study.

Keywords: *Need Assessment, English for Specific Purpose(ESP), English for Film and Television Studies, English as a Second Language(ESL)*

A Statistical Analysis of Test Scores of Young Sri Lankan English as a Second Language (ESL) Learners in Onsite Summative and Online Summative Examinations

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The present study is a quantitative study that aims to analyze Computer-Based Language Testing and its effectiveness against the onsite summative written examinations. Online examinations or computer-based language tests have become a popular testing method in the recent past due to the Covid-19 pandemic. The grade 6-11 students in Sri Lankan schools who learn English as a Second Language are selected as research participants whose grades at two different (online and onsite) examinations are analyzed using SPSS. The key question examined in this study is whether the two test formats (onsite written examination and online written examination) can be considered equivalent both pragmatically and theoretically. The findings of this study will be of significant value to teachers of English as a Second Language and Students who learn English as a Second Language. The present study is based on concurrent validation, which focuses on the degree of equivalence between two test scores. The participants of the study were 30 students at a private education institute that offers online tuition in English. The sample was selected from a population of 109 students. The convenient sampling method was used to select the sample of the study and the sample contains 5 students from each grade, from grade 6 to 11. The findings prove that onsite tests are more valid and effective than online tests as there is a significant gap between the scores of the onsite examination and onsite examination. Furthermore, the analysis proves that the test takers have outperformed in online examination whereas scores of onsite test fall onto a regular distribution around a single mean. The findings problematize the effectiveness and validity of online examination as a successful language evaluation method.

Keywords: *Language Assessment, Online Examinations, Validity, Relevance, Test Scores*

A Needs Analysis Seeking the Baseline for a Language Skills Curriculum : (A Case of Non-Starter Engineering Apprentices)

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Individual differences contrive some learners to achieve greater aptitude while the others are forced to remain non-starters. An orthodox curriculum for teaching of English as second language is determined upon a comprehensive needs analysis thus optimally accommodating the learner demands. Universal to any curriculum is that a few learners fail to achieve expected learning outcomes and hence they remain the non-starters of the learning mission. This needs analysis is a response to admit the demands of such non-starter learners thereby seeking baselines to materialize an English for specific purpose solution. Seventeen non-starter engineering apprentices of a Sri Lankan university were subjected to the needs analysis via the tools of; a preliminary dialogue; a diagnostic test of linguistic demands; and a questionnaire survey. The data collected underwent a qualitative analysis catering to the didactive purpose and thematic nature of needs. Learners' limited exposure to vocabulary and genres were the challenges behind the non-starter status extended by grammar knowledge gap and the incompetency in strategies to master the four skills of language. The diagnostic test of linguistic demands manifested a profile of the linguistic demands be included in the prospective curriculum shedding clear light on required portions of each component. Learners have perceived vocabulary as the dominant cause for the difficulties whereas issues in; grammar, cohesive devices and genre being the other causes. The force of intrinsic motivation over extrinsic aspects confirmed that the learners' less effective motivation corresponds with less drive for language learning. The study informed the educator to locate objectives of the curriculum determining the content, themes, tasks and assessment at learner interest that can optimally work for the subjected learners. The study confirmed the fact that a needs analysis with precise tools of data collection attuned for the scope is capable of serving as the baseline for the development of a language skills curriculum.

Keywords: *Curriculum Design, Diagnostic Test, English for Specific Purposes, Needs Analysis, Non-starters*

Impact of Explicit Reading Strategy Instruction on Literal Reading Comprehension of ESL Learners in a State School in Sri Lanka

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Reading in a second or foreign language is considered as one of the most difficult tasks that most ESL / EFL students face. When reading, students need to comprehend what they read. In fact teachers can provide ample guidance to their students by giving explicit reading strategy instruction to develop their reading comprehension skills. Yet, there seems backwardness in providing proper guidance by the teachers to their students in this regard. The same situation can be seen in the Sri Lankan teaching context also. Hence, this study is motivated by the fact that, most of the teachers in Sri Lanka may not practice explicit reading strategy instruction when they teach reading comprehension. Therefore, the purpose of this study was to examine whether explicit reading strategy instruction has an impact on literal reading comprehension. The present study is designed as a quasi-experimental research study. The population was 40 Grade 10 students in a state school in the Galle district and those students were divided into two groups: experimental group and control group. The sample was selected by using convenience sampling technique. The data was gathered qualitatively and quantitatively. The instrument for collecting data was tests and semi-structured interviews. The experimental group had the intervention with a focus on explicit reading strategy instruction while the control group was taught using strategies other than explicit reading strategy instruction. The pre-test was re-administered in the posttest and given to both the experimental and control group. The gathered data was analyzed using SPSS software and thematic analysis. The results of both quantitative and qualitative data postulated that explicit reading instruction has an impact on literal reading comprehension and students improved their literal reading comprehension after receiving explicit reading strategy instruction.

Keywords: *Explicit Reading Strategy Instruction, Literal Reading Comprehension, Reading Strategies, Scanning, Skimming*

Teaching Grammar Not a Fiasco Anymore: The Exploitation of the Inductive Approach to Teach Grammar in a University Context

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This study aimed at drawing a comparison between the effectiveness of employing deductive and inductive approaches in teaching English grammar. Deductive teaching of grammar as discrete units has been a common practice in English as a Second Language (L2) classrooms which makes the teaching and learning process exhausting for learners. In contrast, teaching grammar in context is expected to expend a limited amount of time, simultaneously enabling the teacher to encompass a wide range of grammar aspects. A group of 50 students who obtained average (45 – 50) marks for the placement test of the intensive course was selected from the first-year students of the Faculty of Science and divided into two groups each consisting of 25. Both the Control Group (CG), and Experiment Group (EG) were exposed to 10 one-hour-long lessons on tenses and modal verbs, providing instructions using lesson materials based on the deductive approach and inductive approach respectively. Before and after the intervention of each approach, a written communicative exercise based on grammar taught for the EG and CG, in which they had to fill in twenty blanks of a letter was administered. Besides, a focused group interview was conducted using a semi-structured questionnaire with 20 students, randomly selecting 10 from each group. The students' performance was quantitatively analysed while their perceptions were qualitatively analysed to discern the efficacy of the two approaches. Based on their marks it was revealed that inductive teaching of grammar is indispensable for exploiting the language meaningfully in authentic situations. Moreover, the perceptions of the students have displayed a clear preference to learning grammar in context over the discrete point teaching of grammar. However, the productivity of this approach is determined by the teaching strategies employed by the teachers and the appropriate selection of lesson materials related to contexts.

Keywords: *In Isolation, In Context, Second Language, Teaching Grammar, Undergraduates*

The Effectiveness of the Compulsory English Language Program (CEP) of a State University in Sri Lanka

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This evaluation assessed the effectiveness of the Compulsory English Program (CEP) of the Faculty of Humanities and Social Sciences (FHSS) in a state university of Sri Lanka. The CEP was implemented between 2019 and 2020 funded by Accelerating Higher Education Expansion and Development (AHEAD) project. The overall purpose of the evaluation was to generate substantive evidence and knowledge to inform the university authorities about the effectiveness of the project. The aim of the evaluation was to assess the extent to which the expected results of the project have been achieved. This evaluation was a comparative analysis of the CEP outcomes in two selected batches of first year students admitted to the FHSS. Baseline data of the 2019 intake of students were considered as before intervention and data pertaining to 2020 intake was considered as after implementation of the project. The evaluation used a mixed methodology where quantitative measures were supported by the qualitative information. The students' writing and reading skills were assessed by comparing writing test marks of the year 2019 and 2020 while the students' speaking and listening skills were assessed by comparing oral test marks of the year 2019 and 2020. The average writing test score among first year students has increased after the project by 6 marks. Without project average writing test score was 51 in 2019. After project test score was 57 in 2020. Without project Average oral test score is 63 in 2019 but 2020 results can't be identified due to the COVID-19 "New Normal" conditions. Percentage of permanent staff attendance has increased by 34%, while permanent staff teaching hours has increased by 34.32%. Teachers were satisfied with the activities on curriculum development, and 90% of students were satisfied with in-class teaching and teaching methods. In conclusion, the average writing test score among first year students has increased but the project has not attained the expected change of the project outcomes by improving the writing, reading skills of students in the FHSS, thus speaking and listening skills were not assessed due to the current pandemic situation, but the project has improved teachers' engagement of the teaching activities.

Keywords: *Effectiveness of Language Development, Undergraduates*

Validity of an Online Reading Assessment: A Survey Among Sri Lankan University Students

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English Language Teaching (ELT) usually focuses on teaching and learning the four skills, namely reading, writing, listening, and speaking. However, reading is considered to be the most essential skill for academic success as it is a skill necessary to gather the information that is stored in printed text forms everywhere. The present paper aims at the validation of a reading test targeted at learners at a tertiary level of education. An online reading test using Google form was administered to 124 students. The responses were subjected to Rasch Measurement Model (RMM) Analyses using the Winsteps version 4.4.7 software to find out the psychometric properties of the reading test. The findings revealed that the person and item reliability of the test were .77 and .91 respectively. The analyses indicated the dimensionality of the reading test and provided evidence that the online reading test was valid and reliable to assess the reading proficiency of the tertiary level students. The study provided insights on the utility of using the RMM analyses in the validation of a reading test to measure the reading ability of second language learners.

Keywords: *Assessing Reading, Validation, Reading Test, Rasch Measurement Model*

Linguistics and Language Studies

A Content Analysis on the Syntactic Features of Sri Lankan English Identifiable in Selected Sri Lankan English Dramas

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Standard Sri Lankan English is a distinct variety which exhibits features that differ from other varieties particularly from standard British English and American English. These distinctive features can be identified in different aspects of language as in morphology, phonology, and syntax. Thus, the current study deals with syntactic features which exhibits the distinctive quality of Sri Lankan English. In fact, as per the claims of Herat (2001) and Gunasekera (2005), Sri Lankan bilinguals of Sinhala/Tamil and English often tend use syntactic features which have the influence of their first language which is mostly evident in colloquial speech. Consequently, the current study is based on dramas which can be identified as a literary genre which deals with authentic contexts which present in authentic language. Thus, in this mixed method study the purpose was to identify the Sri Lankan English syntactic features which are apparent in Sri Lankan English dramas which distinguish the variety from the Standard British and American English. This study presents data from a purposive sample of 6 Sri Lankan English dramas which have won or have been nominated for the Gratiaen prize from 1994 to present. The methodology incorporated in the present study was content analysis through which data was analyzed according to the theoretical framework built based on the research findings of the scholars; Passe (1955), Kandiah (1979), Gunasekera (2005) and Herat (2006). The present study reveals that Sri Lankan English dramas have been incorporated syntactic features like the use of tags, topicalization, substitute one, verb deletion in questions, pronoun deletion, use of Here! instead of a name, use of two verbs, duplication in colloquial usage, expressions (interjections) from Sinhala and Tamil, idiomatic expressions translated from Sinhala and Tamil, gendered syntax, and word order. Simultaneously, the study results account that among the above syntactic features; pronoun deletion, use of tag questions and equality markers, verb deletion in questions, substitute 'one' and topicalization can be identified as the most productive syntactic features of Sri Lankan English. Subsequently, this study will contribute to the knowledge of the field of Sri Lankan English Syntax.

Keywords: *Sri Lankan English, Sri Lankan English Syntax, Sri Lankan English Dramas, Content Analysis*

A Study on the Impact of Task Based Language Teaching on Improving Chinese Writing Skills

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Chinese language, which belongs to the Sino-Tibetan language family, is widely used worldwide for myriad purposes as a communication tool. As a result, Mandarin Chinese is taught in many foreign countries as a foreign language. Since early ages, linguists have introduced various language teaching methods and were practiced in language teaching in diversified models. The Task-Based Language Teaching is considered the latest trend and an emerging efficient method that responds well in teaching languages. This study has focused on using Task-Based Language Teaching to enhance the Chinese writing skills of beginner Chinese language learners to communicate competently and ensure the quality of their communication. The study's main objectives were to explore and identify the difficulties faced by beginner Chinese learners when they write in Chinese and identify the effectiveness of using tasks in teaching Chinese to reduce those difficulties and meet the intended outcome. The study was conducted based on a sample of 40 beginner Chinese language learners of the Department of Tourism Management, Sabaragamuwa University of Sri Lanka. Task-Based Language Teaching Method was applied to give a pre-test and a post-test to collect data. The final results prove that using tasks is effective in enhancing Chinese writing skills vigorously. Further, a questionnaire survey was conducted to comprehensively gather data about the currently used learning methods. Along with the constructive answers that lead to the conclusion obtained by the researcher by analyzing results, this study depicts that using tasks to improve writing skills enhances comprehensive writing skills and exposes the beginner learner to respond in communication competently in the real world. Further, it is undeniable that foreign language teaching concepts are better to be reorganized and adopt innovative models to ensure the quality of language knowledge.

Keywords: *Language Teaching, Task-Based Language Teaching, Teaching Chinese as a Foreign Language, Writing Skills*

Intangible Cultural Heritage and Cultural Untranslatability in English Translations of Sinhalese Literary Texts: A Comparative Study of the Trilogy by Martin Wickramasinghe and its English Translation

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Translating literary texts highly embedded with intangible cultural capital is an utmost challenge to a translator. Vocabulary that represents intangible cultural capital encapsulates a massive cultural background. Consequently, despite the words are replaced with different morphological processes in the translation, the main purpose of translating the target text into another language can be unsuccessful as the target audience does not possess the cultural knowledge of source cultural background. Thus, translations generally hinder the original cultural essence. The main purpose of this comparative study is to discuss the limitations in translated literary texts in terms of intangible cultural heritage, with reference to Martin Wickramasinghe's trilogy and its English translation. The complete methodological process of the research was qualitative. The methods of desk review and interviews were used to collect primary data. The main source texts of the research; *Gamperaliya-Uprooted*, *Kaliyugaya-Age of Kali* and *Yuganthaya-Destiny*, and various other sources were referred as primary data collection sources. The study arrives at a conclusion that loss of connotation, deletion of information, meaning change, and unfamiliarity are the major limitations found in the translation, resulted by lack of equivalents, cultural gap, and having different values in the equivalents. The study brings three suggestions; (i) borrowings, hybrid compounds, and familiar calques should be used to reflect the lexical items, (ii) implied meaning of the idiomatic expressions should be given rather than paraphrasing the surface meaning and (iii) the meaning of borrowings, hybrid compounds, and calques, and the background behind cultural practices should be given as footnotes or end notes, to make the translations even subtle.

Keywords: *Comparative Analysis, Cultural Capital, Intangible Cultural Heritage, Literary Translations*

Literature, Feminism and Film Studies

An Exploration of the Impact of Male Gaze on the Feminine Identity and Sexuality in Sri Lankan Cinema: A Case Study of Asoka Handagama's Selected Works

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The voyeuristic and scopophilic representation of women in media shapes the feminine identity and sexuality of different cultures and societies. This research aims at examining the portrayal of female identity and sexuality specifically in Sri Lankan cinema by referring to the selected works of the veteran filmmaker, Asoka Handagama. The award winning movies, "Thani Thatuwen Piyambanna" (Flying with One Wing, 2002), "Aksharaya" (A Letter of Fire, 2005), "Aege Aesa Aga" (Let Her Cry, 2016) and "Asandhimitta" (2019) which feature significant female characters and their plight in the patriarchal society are selected as the sample of the research. The insights of Simon de Beauvoir, Sigmund Freud and Michel Foucault, Jacques Lacan and Laura Mulvey laid the basis for critical exploration of women's representation in media which has been highly discussed in the feminist works. Thus, the researchers have deployed the Male gaze Theory, influenced by Laura Mulvey along with the Lacanian and Freudian concepts of gaze as the theoretical approach of the study. Qualitative approach was utilized in conducting the research and textual analysis of the selected movies and interviews focusing the director, critics and academics were the major tools of primary data collection. Research publications, sources from the internet and newspaper articles were the major secondary data collection methods. Even though the Male Gaze Theory illustrates that women are always projected as passive objects in cinema, the findings of the research depict that the selected sample represent the female figure as an assertive and emphatic entity regardless of the persistent patriarchal norms. The findings of the study will open new avenues for future researchers.

Keywords: *Feminine Identity, Gaze, Male Gaze Theory, Sexuality, Cinema*

Does the Pursuit of Desire Elevate Womanhood into Emancipation and Self-Annihilation? Psychoanalysing "Madame Bovary"

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By analysing the key character developments in Emma in the novel *Madam Bovary* this study argues that desire in western femininity challenges the stereotypical representation of the submissive role of a woman. In contrast to the general submissive portrayal of woman, the western woman in Gustave Flaubert's *Madame Bovary* expounds the ability of a woman to traverse beyond the given societal norms until she meets her desire in the fearless amalgamation of self-elimination. As a qualitative study, this paper deploys the Freudian psychoanalytical conceptualization of desire and death drive as fundamental existential condition to truly live as a unique individual being. Emma Bovary challenges death in achieving her imaginary life of infinite happiness. Her Western-ness can be evidenced through her prioritization of desire, unconventional individuality, and fight over subjugation and embarking on an adventurous journey to the threshold of death. As a conclusion the western woman depicted in 'Madame Bovary' shows the possibility of a journey despite the self-imposed confinements that restrict a woman from exploring new horizons of desire. Emma's choice of death as the form of emancipation may elevate her into a new form of female autonomy through self-annihilation.

Keywords: *Desire, Self-annihilation, Emancipation, Western femininity*

Kazuo Ishiguro's Acclamation of British Self as the Authentic Place of Belonging - In relation to the Remains of the Day

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This study reinforces Kazuo Ishiguro's expedition of his authentic spatiality of belonging by deviating from his Japanese self to the acclamation of a complete British self. The objective of the study is to explore Kazuo Ishiguro's transition from cultural hybridity to a universal identity with the creation of a complete English novella. As a qualitative study, the research focuses on 'The Remains of the Day' (1989) that deploys a complete de-territorial shift from Japanese cultural legacy to a novice spatiality which is problematic for a migrant to relate successfully. Ishiguro's novice transcendental spatiality transgresses cultural spaces into an space that locates him in a new existential space beyond a migrant. Ishiguro's successful transgression from his cultural migratory position characterizes him with a new trans migratory position. This identification deviates him from the set of reactionary writers who is full of the hurt ego of leaving the native backdrop. Ishiguro employs memory as a new existential space which is parallel to Steven's detachment from fragments of memory after the meeting of Miss Kenton and acclamation of his authentic place of belonging as a great butler further serving Mr Farraday that refrained from inclinations to return with Miss Kenton. Steven's journey in quest of Miss Kenton and the final disillusionment is parallel to Ishiguro's possibility to negate his cultural hybridity and relating to a complete British self. Ishiguro's skilful juxtaposition of memory in diversified phases upsized his forte of using literature imaginatively. This manifests Ishiguro's capability to acclaim the British self as the authentic space of belonging which many Postcolonial writers find problematic. This capability evidenced Ishiguro as a writer with universal recognition.

Keywords: *Existential Crisis, Ishiguro, Memory, Spatiality*

Representation of Post - Colonialism and the Crisis of Identity through Salim's Character in the Novel *A Bend in the River* by V.S. Naipaul

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Post-colonialism refers to the historical period when colonies gained freedom from western colonization. It represents culture, race, ethnicity and human identity of people who attained independence from the colonial regime. In a post-colonial context, the question of identity is one of the most controversial issues. *A Bend in the River* by V.S Naipaul is a representation of post colonialism and identity crisis through the protagonist Salim who struggles in a post-colonial context that are still persisting in the form of chaos, bloodshed as well as corruption. The aim of the study is to identify how post colonialism and the crisis of identity demonstrate through the iconic character, Salim. The research is primarily qualitative research. The primary data was collected through the in-depth analysis of the novel "*A bend in the River*" and the secondary data was collected through scholarly articles, journals and websites. The study used literary and content analysis for the interpretation of data. Edward W. Said's ideological approach in "Orientalism" and "Culture and Imperialism" has been taken in to consideration as the theatrical approach. The findings of the study articulate that a background of a person essentially determines his fate. As Said's identification of post colonialism, occident exploitation of the orient led expatriates like Salim to embrace the contradiction and conflict of the territory which led to inevitable identity crisis. Salim places himself in the bleak, cynical world in Africa with all the chaos and it influences on Salim's pessimistic personality. Moreover, the inevitability of occident counts against western paradigm in a postcolonial context led Salim to displace himself, accept his crisis of identity and overcome the shadows of colonialism in Africa. The study concludes that Salim's personal struggle and dilemma symbolize the crisis of entire migrant in a postcolonial territory and therefore identity crisis is an inevitable outcome for the expatriates.

Keywords: *Identity crisis, Post-colonialism, Orient, Occident*

Synchronization in Dubbing and the Responses of Different Age Groups

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Dubbing refers to the replacement of the verbal components of an audiovisual product with another audio track which is the translation of the original. In translating for dubbing, one of the most crucial factors to be taken into consideration by a translator is the concept of synchronization. The synchronization should be evident in a dubbing product in three prominent forms: lip synchrony, kinetic synchrony, and isochrony. The general perception in dubbing is that among the three types of synchronies, isochrony should be prioritized over the other two synchronies. This research aimed at investigating the effects of complete isochrony over partial lip synchrony in dubbing on the audience with special reference to the two major audience groups; adults and children. The study followed both qualitative and quantitative approaches. The Sinhala dubbed movie, The Lord of the Rings, Fellowship of the Ring, were selected as the sample material. For ease of analysis, the utterances in the first five minutes of each hour of the movie were selected. Firstly, the statuses of isochrony and lip synchrony evident in the selected utterances were assessed through comparative analyses. After establishing an idea on the available levels of isochrony and lip synchrony in the video clips, the responses of the audience were observed. It was noticed through the interview that, for fifteen out of twenty adults and nineteen out of twenty children, the lack of lip synchrony in the video clips was not a contributing factor in disrupting their viewing experience as long as complete isochrony was ensured in the dubbing product. The study ultimately proved that, in dubbing, lip synchrony is not as crucial as isochrony. The coherence between the durations of utterances seen on the screen and heard on the audio is the most contributing type of synchrony to create a successful dubbing product.

Keywords: *Audience Responses, Audiovisual Translation, Dubbing, Lip Synchrony, Isochrony*

Conceptualizing "De-territorialization" via Selected Literary Texts of Shyam Selvadurai and Nayomi Munaweera

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The study associates a passage of communication of the genre of Sri Lankan Literature in English and it examines the causes and effects of the process of "de-territorialization" with reference to the literary works of Shyam Selvadurai and Nayomi Munaweera. The selected works of the two iconic immigrant authors: "Funny Boy" by Shyam Selvadurai and "Island of A Thousand Mirrors" by Nayomi Munaweera will be analyzed by focusing on the concept of "de-territorialization" "Re-territorialization" through the lens of Cultural Studies emphasizing Homi K Bhabha s' "Location of Culture"(1994). This addresses the literary presence of the liminal spaces within the land block of Sri Lanka. Collectively the sample articulates the causes and effects of de-territorialization through the qualitative approach to reach the research conclusions. The study was primarily conducted through a desk review of the two novels, supported by other theoretical and supplementary works. Major findings of the research were supported by the results of a questionnaire survey conducted by focusing the English reading community as the sample of the data collection plus the interviews conducted by the researcher. The political enigma, ethnic conflict and identity crisis which are the main rationale to the de-territorialization will be discussed through the interpretative tools of Cultural Studies and Anthropology. Ultimately the study envisions that it is always better to live with coexistence, respecting the liminal identities and differences with a broad mindset than seeking territorial shift as the sole option.

Keywords: *Co-existence, De-territorialization, Identity Crisis, Liminal Spaces, Territorial Shift*

"Uncaged Cage-Birds in The Storm": Convention and Feminine Individuality in Kate Chopin's *The Awakening* and Angela Carter's *The Bloody Chamber*

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The universal problem of the female is their interminable quest for individuality and liberty. Amidst the subjugation of patriarchy and conventional oppression how would the female be authentic? Does this world stand a chance for her to be authentic? Therefore, this study aims at identifying the deeper dimensions of the hegemonic powers of patriarchy and contemporary societal conventions obstructing the individuality of the females degrading them into passive, docile and vulnerable creatures, manipulated by the patriarchy. This can be identified as a pressurizing, universal delinquent for the modern women. How she finds solace and liberation becomes dynamic to one another. In this undertaking, the objective of the authors is to assess the deeper fathoms of patriarchal hegemony and its' destructive power upon females. The popular Victorian texts *The Awakening* by Kate Chopin and *The Bloody Chamber* by Angela Carter are subjected into the analysis, which contain the extreme female subjugation under the patriarchal hegemonic dominance. Marxist feminist theories of Simone de Beauvoir, Judith Butlers' Performative Theory and the Theory of Objectification by Frederickson and Roberts are used to substantiate the discourse in the study. Thematic analysis method is used as the methodology of this qualitative study. The research results in identifying the timeless fathoms of the marginalization of the female passion, personal space and the individuality invaded by the invisible forces of patriarchy. And thus, the study evaluate how the modern woman breaks these iron bars of gender oppression of the hegemonic power and societal convention to reach the heights of individuality.

Keywords: *Feminine Individuality, Hegemony, Patriarchy, Societal Convention*

Research and Education

A Comparative Study on Scientific and Literature Based Thematic Analysis in Social Science and Humanities Researches: A Case of University of Sri Jayewardenepura Sri Lanka

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Generally, social science research heavily relies upon literature-based studies to draw conclusions about social phenomena. However, the excessive application of literature-based thematic research is likely to impose a limitation in studying actual social behavior. Therefore, the preference of Sri Lankan undergraduates of Faculties of Social sciences and Humanities over scientific and literature-based thematic analysis was tested in this study. The 165 focused group sample size was selected which represents 5 Departments at the Faculty of Social Sciences and humanities, University of Sri Jayewardenepura. Data were analyzed using statistical methods and content analysis. It was revealed that the respondents are more focused on literature-based thematic studies rather than scientific and statistical analysis. Structured interviews, content analysis were used as the main methods of data collection. The in-depth interviews were continued with an interview guide which was designed with open-ended, closed questions, Likert scale, binary questions, and numerical values. Content analysis was used as a research tool to determine the presence of themes or theories (concepts) within some given qualitative data. It was found out that that majority of the students of the faculty tend to select literature based thematic analysis rather than statistical or scientific analysis. This is a consequence of factors such as higher proportion of female students who usually have the tendency to step away from lab and field work, lack of resources to engage in scientific methods, lack efforts to be put forth, high budgets required, lack of available knowledge and practice on statistics, academic staff's encouragement towards thematic method etc. The importance of combining literature-based studies and the scientific methods was highlighted.

Keywords: *Social Science, Humanities, Future, Analysis, Thematic, Scientific, Sustainable*

A Textual Analysis of the Pedagogical Framework of Poetry in *The Appreciation of English Literary Texts* at the G.C.E. O/L in the Sri Lankan Context in Relation to the Overtly Specified Thematic Prescription(s)

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The subject *Appreciation of English Literary Texts* at the G.C.E. Ordinary Level is a subject that stands as an entry point to the study of English Literature for students pursuing English Literature studies in the Sri Lankan secondary education context. In this context, the pedagogical framework as projected by the Teacher's Resource Book plays a major role in the approach for facilitating the study of the subject. This study textually analyses the pedagogical framework therein prescribed for the poetry section of the subject in relation to the specific thematic approaches i.e. 'Nature, Conflict, Society, Life and Humour' as designated in the framework of the poetry section. The study investigates as to whether the specific thematic designation as such, compartmentalises the approach to the said poetry glossing over the multiplicities of thematic approaches poetry possesses. The analytical study of the pedagogical framework prescribed for the poetry section comparatively analyses specific teacher responses of those engaged in the online teaching of the subject in the larger setting of the global COVID-19 pandemic, in their approach to the teaching of the said poetry. Thus the study employs a mixed methodology in terms of a textual analysis and a questionnaire in the investigation of the aspects of compartmentalisation and multiplicity in relation to the thematic approaches of the prescribed poetry. The study asserts that compartmentalising the pedagogical approach to the prescribed themes as stipulated therein problematizes the approach to the teaching of poetry for there is a glossing over of the multiplicities of interpretations the said poetry accords.

Keywords: *Poetry, English Literature, G.C.E. O/L, Pedagogy, Theme(s)*

Characteristics Associated with the Metacognitive Awareness of Mathematics Teachers at the Junior Secondary Level of Education in Sri Lanka

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Teaching with metacognition is one of the overlooked areas in educational practice and research in Sri Lanka. Educating metacognitive individuals has become an important concern in the development of autonomous learners; who think, act, and take decisions based on reasons. The association between Metacognitive Awareness (MA) of mathematics teachers and teacher characteristics has been studied in other countries but there are no published researches on the same phenomenon in Sri Lanka. The current study attempts to identify whether there are associations between mathematics teachers' MA and their characteristics. To achieve this purpose two main objectives have been set: to identify the existing level of the MA of mathematics teachers; and to identify the association between the MA of mathematics teachers and teacher characteristics such as years of experience of teaching, highest educational qualifications, and professional qualifications. Data for this study were collected from 61 mathematics teachers who teach Grade eight classes in the Matale District of Sri Lanka. A questionnaire consisted of questions adapted from the Metacognitive Awareness Inventory for Teachers (MAIT) was used to gather information on the mathematics teachers' demographic data and their MA in teaching mathematics in their classrooms. The Confirmatory Factor Analysis indicated good/acceptable model fit and convergence of each factor. Moreover, alpha scores of the inventory signify that the inventory is internally consistent. These findings reveal the utility of the MAIT-20 in measuring the MA of mathematics teachers. The data were analysed using Excel, SPSS, and AMOS software. The findings reveal that the MA level of the teachers was varied according to their professional qualifications, gender, age, and subject studied for their bachelor's degree programme. Moreover, the subjects studied by mathematics teachers for their G.C.E. (A.L.) and their teaching experience did not influence teachers' MA. Accordingly, teachers with strong MA are the ones who make a difference in education. Thus, it is necessary for mathematics teachers to assess their MA and to improve metacognitive skills.

Keywords: *Mathematics Teachers, Metacognition, Metacognitive Awareness, Metacognitive Knowledge, Metacognitive Regulation*

Factors Affecting to the Motivation of Female Academics on their career: A Case Study at University of Sri Jayewardenepura, Sri Lanka

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Number of researches have been conducted related to motivation in different countries. Here, the researcher was interested to conduct this study with reference to the motivation of female academics at universities in Sri Lanka based on the research gap identified as per the literature survey. By conducting this research, the factors affecting the motivation of the academics were identified and it will further be beneficial for increasing the motivation on career of academics. Motivated staff will contribute more to the university. With the recommendations that are expected to be provided based on the findings of this study, it is expected that it would be more beneficial for improving their performance and productivity. This research has been conducted as a descriptive type of study. Study population is all the academics in USJP. The size of the sample is 20 and the sample has been selected randomly. By using In-depth interviews, primary data were collected. Secondary data were collected using journals, documents and records of internet and previous research. Gathered data has been analyzed qualitatively. According to this study, the factors which drive female academic members at University of Sri Jayewardenepura towards the motivation were identified as payments, freedom, leadership, advancements, and empowerment, recognition and work relationships.

Keywords: *Female Academics, Advancement, Motivation, Performance, Productivity*

Nudging in Online Education: Interventions on Undergraduate Students' Level of Engagement, Sri Lanka

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Due to covid-19, the transition from traditional education to online education had a significant influence on both students and instructors, despite the fact that it came all of a sudden and there was not enough time to adapt. As a result, many students abandon their studies or engage in little interaction in online education rather than attending actual courses, where it created a necessity to study and implement sustainable strategic plans through a socio-cognitive perspective in the education sector. Prior to that, this research looked at the idea of employing nudge interventions to enhance student engagement in online education. First, using a psychometric scale, this study aims to determine the amount of student involvement in online education. Second, using the study population as a case study, the study looked at how students' levels of involvement differed depending on their demographic factors. Finally, as a choice experiment, framing nudge interventions were delivered to the research population in order to determine the effectiveness of nudge in predicting students' degree of involvement in online education. Data were collected from 97 second and third-year undergraduate students who are currently enrolled in one of the three-degree programs offered by a public university and receive their lectures via the Zoom platform. The causal link between framing nudges and students' degree of involvement in online education was estimated. The research sample exhibited a modest level of online education involvement, which is insufficient and may be improved. In terms of some demographic factors, students' levels of participation in online education differed ($P<0.05$). This study found that informative framing was a significant and positive predictor of the students' degree of participation in online education in the study group. Implementing these behavioral insights will result in a significant long-term investment in the education business, notably in online learning.

Keywords: *Framing, Level of Engagement, Nudge, Online Education, Undergraduates*

Perception of the Impact of Grade Five Scholarship Examination on Tertiary Education in Sri Lanka

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Primary education is identified to be very crucial in determining the growth and development of an individual where examinations are found to be part and partial of the contemporary education system. Adhering to the competitive nature, the Grade five scholarship examination is viewed to be a stressful examination that could possibly impact either negatively or positively on a child's complementary levels of learning. Thus, the present study analyses the undergraduates' perceptions of the impact of the Grade five scholarship examination on their tertiary education. This followed a qualitative approach where data were collected from the thirty (30) respondents through in-depth interviews. Judgemental sampling technique was utilized to select the sample where the collected data were analysed through thematic approach. The findings unveiled five (05) common themes of agreement where majority of the respondents did not perceive an impact of the specified examination on tertiary education where few respondents highlighted their experience on being either negatively or positively impacted. Thus, the study revealed a major perception of the absence of an impact of Grade five scholarship on tertiary education. Yet, as most of the parents and society still believe that students should pass the grade five scholarship examination whilst some exerting unnecessary pressure on their children, the findings are expected to be noteworthy not only for the parents but also for the government on taking corrective measures to eradicate the negative consequences while strengthening the authentic purpose of the examination.

Keywords: *Education, Grade-five, Scholarship Examination, Tertiary Education*

Sociology

Anthropology of Structural Transformations of Modern Chena Cultivation in Sri Lanka

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This research is about modern transformation of traditional chenas society and culture. It tries to fill up research gap of scrutinizing inter and intra communal relationships of concurrent chenas economy in Sri Lanka. While the primary data of the research were fulfilled by personal observation and interviewing held with chenas-farmers who could meet within their own agricultural lands comprising selected areas in Anuradhapura and Monaragala Districts that it decidedly consists of conceptual interpretations on sociological as well as anthropological platform. The data has been generated by informal interviews with key informants, focused group discussions conducted in an irregular manner and through personal observations. The data has been interpreted basically in the qualitative manner. This paper argues, in spite of old residuals structures of chenas cultivation system is existed as it is, its internal communal mode has been crumbling. The peasants are adapting into modern market relations rather than depending on conception relationships of 'part-culture'. While transforming from multi variant crop farming to selected along with limited market oriented varieties, all other human relationships are being altered from bonding to bridging. The shifting of internal mechanism of chena's traditional eco-based irrigation system to durable agricultural-well water treatment and many other evolutions marks deteriorate in-community networking such as attam, and other reciprocal types. The weaker ties built with commercial networks seem to be predominating over the system. Therefore, this study explores further reliable perception to understand the mode of production of modern chenas economy.

Keywords: *Chenas Economy, Culture, Production Relations, Transformation*

Criminal Behavior of Drug users in urban Sri Lanka: With Special Reference to Colombo District

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Drug use is a major social problem facing many countries around the world. As a by-product, various social problems have arisen around it, including the social phenomenon of crime. The main problem of the study was to find out what forms of criminal behavior is shown by drug users in an urban environment. The main objective of the study was to identify the forms of crimes induced by drug users in an urban environment. Specific objectives were to identify socio demographic factors such as gender, marital status, level of education, employment and level of income of drug users who committed crimes. Fifty drug users who had committed some kind of crime were included in the sample using the snowball sampling method. Survey method and case study method were adopted for the study. In the study sample, 18% were female drug users and 82% were males. It was revealed that the majority of drug users, 42%, were unmarried and 38%, were educated up to primary level. The drug users represented in the sample were poly drug users and 76% were daily heroin users. 16% of drug users have committed crimes under the influence of drugs. Drug users had induced drug-defined offences. That is drug possession (74%), drug sale (24%), drug trafficking (20%), drug distribution (18%) and illegal alcohol production (2%). The study revealed that in addition to the drug defined-offences mentioned above, drug users are involved in a variety of crimes. These included theft (76%), house breaking (38%), robbery (32%), pick pocketing (22%), engaging in commercial sex work (18%), grievous hurt (14%), destruction of property (12%), money and property fraud (6%), kidnapping (4%), homosexuality (4%), attempted homicide (4%), homicide (2%), rape (2%), and grave sexual abuse (2%). It can be concluded that drug users have a high tendency to induce drug- defined offenses. Organized crimes, minor crimes as well as grave crimes can be identified among drug users. It can be further concluded that drug users commit certain crimes under the influence of drug use and have a tendency to commit multiple crimes.

Keywords: *Crime, Drug Use, Homicide, Homosexuality, Urban*

Parental Knowledge About Early Childhood Development in Estate Sector in Sri Lanka

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The discourse regarding 'parenting' in Sri Lanka gets little attention and very little research has been conducted in this field. Even within the limited research thus far carried out, focus has primarily been on how parenting practices influence children's mental and physical health. Therefore, the aim of this study is to explore the knowledge, attitudes and practices regarding early childhood development that parents have in the estate sector in Sri Lanka. In this study, mainly qualitative research methods were employed and data collection tools were interviews and observations. One plantation sector in Kandy district in Sri Lanka was selected as the research field and the sample consisted of 31 respondents as 25 mothers and 5 fathers, plus 1 midwife of the particular area. This study finds that both mothers and fathers have limited, rudimentary knowledge about childhood development. They also display the attitude that parenting is a matter of course which does not require specific knowledge or skills. The socio-economic background has a strong link with this situation; mainly poverty, domestic violence, cultural ideologies, limited education combined have prevented parents perceiving this field as of any importance in gaining their children a better life, something they do sincerely aspire to. Therefore, short-term and long-term steps should be taken to promote the importance of childhood development and encourage parents to pay their children more aware parental attention than in the current situation. Therefore, this study recommends employing community level awareness programmes on parenting with a special focus on raising awareness particularly to fathers, as they display even less knowledge or positive attitudes in this field than mothers. Long-term strategies should also be launched to enhance their social, cultural and economic backgrounds as many of the issues in the estate sector are linked to these conditions.

Keywords: *Early Childhood, Parenting, Knowledge, Estate Sector*

Tackling Environmental Degradation as a Global Challenge: An "Egbe Bere Ugo Bere" Philosophical Approach

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Environmental degradation is one of the ten global challenges cautioned by the United Nations' high-level Panel on Threats, Challenges and Change. The degradation comes in various forms such as deterioration of environment through depletion of resources such as quality of water, air and soil; destruction of habitat; wildlife extinction; and pollution. These pose great dangers to human health, quality life, and posterity, hence the need for environmental conservation. This paper, therefore, uses Igbo maxim, "Egbe bere Ugo bere" (let the kite live and let the eagle live, literally meaning: live and let live) to call for co-operative living and symbiotic interaction between human and other elements of the environment. "Egbe bere ugo bere" is a maxim or proverb by the Igbo speaking people of Eastern Nigeria, which lays emphasis on communal and co-operative existence. The work is a qualitative research, employing the methods of critical and conceptual analysis, conversational thinking and deductive reasoning.

Keywords: *Environment, Degradation, Conservation, Sustainability, Philosophy, Igbo*

Eco-friendliness and Sustainability of Shifting Cultivation in Sri Lanka: A Review of Current Management Practices of Shifting Cultivation in the Dry Zone

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Shifting cultivation, locally known as chena cultivation, is a field of cultivation in which the natural vegetation is cut down, allowed to dry and burned. This system originally belonged to the agro-farming system and falls within the larger scope of sustainable agriculture. In recent decades, however, considerable literature has shown that chena cultivation and the people who use it neglect their environmental responsibilities. Therefore, the purpose of this study is to systematically review the current chena cultivation practices in the dry zone of Sri Lanka from an environmental point of view. The study was conducted in Anuradhapura, Kurunegala, and Monaragala Districts using 20 groups focusing on 10 villagers. Descriptive statistics were used for quantitative data analysis and content analysis was used for qualitative data analysis. With Results revealed that currently farmers cut down all the trees in the premises ignoring the principles of chena cultivation. Mechanical saws have been used for this purpose. 62% of the lands has been prepared using tractors and more than 79% of the farmers has used agrochemicals with their cultivation practices. More than 80% of the sample farmers has removed all trees in their field during the last five years. And 23% of the farmers changes their lands annually as there are separate plots for farmers. Only 12% of farmers reported not cultivating land for at least a year. The human-elephant conflict has been exacerbated by the absence of farmland and the depletion of surrounding forests. More than 20% farmers directly faced elephant attack. The study revealed that the patterns of agricultural land use in traditional arid zone villages have changed significantly over the past few decades.

Keywords: *Shifting Cultivation, Dry-Zone, Environment, Management Practices, Sustainability*

Innovative Technologies for Sustainable Development

Innovations are occurring and alternative solutions to the existing problems are emerging in all sectors. Electric cars, organic farming, renewable energy, and e-learning are good examples. Innovations and alternatives are emerging not only in industrialized countries but also in developing countries like Sri Lanka. Meeting sustainable development goals will require action on several fronts, including harnessing and maximizing the potential of technological innovation. Innovations can contribute not only to long-term economic growth but also help address pressing social and environmental concerns. Latest research findings in the areas of Biotechnology, Agriculture, Information and Communication Technology, Mechanical Engineering, Electrical Engineering and Nanotechnology are included in this section.

Plenary Speech by Dr. Rajitha Gunarathne

Processing Innovative Composite Products from Eppawala Chloroapatite

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As a developing country, it is economically beneficial for Sri Lanka focusing more on the sustainable value addition of its natural resources. As a natural phosphate source, the Eppawala Rock Phosphate deposit located at the ancient Anuradhapura district has been considered mainly as a raw material for the production of Phosphorous fertilizers. Considering that, this study explores processing novel composites for industrial application from non-renewable Eppawala Chlorapatite.

First, Chlorapatite mineral was converted into Hydroxyapatite, a kind of ceramic and bioceramic properties using Sol-gel routes and Solid-state sintering techniques. Then considering its bioceramic properties, it was incorporated with Methyl methacrylate (MMA) and 2- hydroxyethyl methacrylate (HEMA) liquid monomers to process bioceramic composites for orthopedic and dentistry applications. Synthesized ceramic varieties and processed bioceramic composites were characterized using PSA, XRF, SEM with EDS, FTIR, XRD, TGA. Also, a cost analysis was carried to find out the economic impact of synthesized products on the Sri Lankan economy. Results were compared and contrasted with commercial products and human hard tissues to find out suitability for biomedical applications.

Next, synthesized Hydroxyapatite varieties were reinforced with polyester, epoxy, E- Glass fibers, Silicon carbide (SiC), and Boron nitride (BN) to process composites for several industrial applications. Processed composite types were analyzed with SEM with EDS, FTIR, XRD, DSC, Tensile test, Impact test, DMA, and TGA. Results were compared with each other to find out suitability for automotive and other industrial applications.

The study concludes that Eppawala Chlorapatite can be directly converted into Hexagonal Hy-

droxyapatite using Sol-gel routes and Solid-state sintering techniques. Synthesized bioceramic and processed bioceramic composites have a close chemical and structural similarity with human hard tissues than commercial products and low cost. Their impurity level (Fe, Al, Si) is similar to bone ash and highly suitable for biomedical applications. Processed composites for automotive and other industrial applications show high chemical, mechanical, and thermal properties. Processing novel composites for biomedical, automotive, and industrial applications from non-renewable Eppawala Chlorapatite gives more profitable and economic benefits than considering as the raw material for fertilizer production.

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Bio-systems Technologies

Evaluation of Accuracy in Hand Grading Technique of Corpora Lutea in Recipient Cows at Multiple Ovulation and Embryo Transfer

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The utilization of embryo recipients with well-developed corpora lutea (CL) is considered an important aspect of the conception rate of embryo transfer (ET) in cattle. The presence of various outgrowths, different shapes, and cysts, the hand grading technique (HGT) of CL in the recipient is a challenge at embryo transfer in cattle. Thus, the objective of the study was to evaluate the accuracy of the above per rectal HGT of CL for embryo recipient cows. A group of Friesian × Jersey cows (n=25) that has been selected as recipients for an ET program in an upcountry farm were estrous synchronized using standard progesterone (1.38g/device) intravaginal inserts protocol. Seven days after the estrous, CL was assessed and graded according to the standard per-rectal HGT. Depending on its diameter, consistency, and prominence, CL was graded into four (A, B, C, and Cystic) categories. Similar grading was carried out for the same group of recipients under the per-rectal ultrasound scanning technology (USST) (6.5 MHz linear probe) and the same grading criteria as the confirmatory procedure. Results of the HGT were compared with the confirmatory procedure. Ultrasound scanning revealed the presence of 11-A, 10- B, 2- C grades, and 2 cystic CL of the cows. The final selection of embryo recipient cows may depend on the identification accuracy in the grade of CL. Overall identification accuracy of the correct grade of CL in HGT was 52%. Diagnosing accuracy of the grade 'A' CL was 45% while 'B' represented 50%. Due to the large diameter, luteal cysts could be identified as grade 'A' CL leading to false-positive results at the HGT. The presence of either grade 'A' or 'B' CL is an essential requirement to avoid the possible conception failure. The ability to diagnose either 'A' or 'B' grade CL at HGT was 86%, while 14% of suitable recipients have missed due to the false-negative identification at the same technique in the study. Hence, it is revealed the comparative lower accuracy in per-rectal HGT of corpora lutea leading to recoverable lower pregnancy rate at embryo transfer programs.

Keywords: *Corpus luteum, Cattle, Embryo Transfer*
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Investigating the Potential of Bioethanol Production using Different Palmyrah Products

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Fossil fuel is widely used as energy source in various fields. The Day today life of human being become difficult due to scarcity, fast depletion and increasing price of fossil fuel, Biofuel can be an alternative to reduce the dependency on fossil fuel. Palmyrah (*Borassus flabellifer*) is an economically beneficial plant which is mainly found in tropical regions. Palmyrah products such as tuber flour, boiled tuber flour, Sweet sap, Treacle, Jaggery are rich in starch, sugars and some nutrients needed for fermentation. Yeast (Saccharomyces cerevisiae) is the common microbes employed in ethanol production due to its high ethanol productivity, high ethanol tolerance and ability of fermenting wide range of sugars compared to other microorganisms. Further, yeast can grow under wide range of pH (2.8 - 8.0). Therefore, this study was undertaken to investigate the potential of bioethanol production using various palmyrah products as medium. Five fermentation mediums were prepared using palmyrah products such as tuber flour, boiled tuber flour, sweet sap, treacle and jaggery. Glucose solution (50 gL^{-1}) was used as the control. This experiment was laid as a Complete Randomized Design with two replicates. The starter culture was prepared by inoculating 5 g of yeast into 100 mL of sterile sucrose solution (50 gL^{-1}) and incubated in a rotary shaker. Each fermentation medium (250 ml) was inoculated with 20 ml of starter culture incubated at room temperature (30 ± 2 ^{0}C) in an orbital shaker (100 rpm). Fermentation time was changed while keeping other factors constant. Samples were taken at different time intervals (24 h, 48 h, 72 h,96 h and 120 h) and after measuring their pH and Brix values they were centrifuged at 10000 × g for 10 min. Supernatants were collected and their ethanol contents were measured using an Ebulliometer. Alcohol concentration (% v/v) was calculated from the Ebulliometer degree table. Data were subjected to Analysis of Variance. Glucose medium resulted highest ethanol yield (3.09% v/v) after 72 hours. Among palmyrah products, after 48 hours, jaggery resulted the highest ethanol yield (2.5% v/v) whereas boiled tuber flour and raw tuber flour resulted 0.75% and 0.87% (v/v) of ethanol yield respectively. Therefore, this study suggested that the palmyrah products can serve as a raw material in bioethanol production.

Keywords: *Bioethanol, Palmyrah Tuber Flour, Yeast, Jaggery, Treacle*

Transfection of MCF-7 Cells for Targeted Knockout of PFK-2 Using CRISPR/Cas9 System

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CRISPR/Cas9 system which enables site-directed genome modifications at the basal level of gene expression is a popular genome engineering technology due to its simple design and easy operation. This research focuses on modifying a vital gene, 6-phosphofructo-2-kinase/fructose-2,6-biphosphatase 3 (*pfkfb3*), which codes for the phosphofructokinase 2 (PFK-2) enzyme involved in the regulation of glycolysis, cell cycle, and apoptosis, through CRISPR/Cas9 system. The intent is to control the growth and survival of cancer cells, by decreasing their oxygen consumption rate. To obtain a successful knockout of PFK-2, 20 nucleotide-long crRNA sequence, and donor template with homology arms integrable into the target locus upon double-strand break following homology-directed repair pathway, were designed after determining a suitable knockout target site through bioinformatic analyses. The chemically synthesized crRNA sequence was cloned into pSpCas9(BB)-2A-Puro plasmid, and the accuracy of crRNA cloning was verified by a colony polymerase chain reaction performed on transformed *Escherichia coli* followed by plasmid sequencing. A high yield of extracted recombinant plasmids was used to transfect MCF-7 cells using polyethylenimine (PEI) as the transfecting agent. Transfected cells were lysed using NP-40 buffer, and the cell lysate was subjected to sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE) followed by western blotting to detect the 6×His tag of truncated PFK-2. Several protein bands around 37 kDa (size of truncated PFK-2) were observed on gel after staining, as expected. The successfulness of the knockout should be further analyzed statistically after performing detection steps for the 6×His tag of the truncated PFK-2 on the blot. This study indicates that the transfection of MCF-7 cells with the afore-designed construct has the potential for targeted knockout of PFK-2 using CRISPR/Cas9 system.

Keywords: *Cancer, CRISPR/Cas9, Genome Editing, Knockout, PFK-2*

Data Science Application & Computational Technology

Hate Speech Detecting In Social Media (Twitter) Using Text Mining.

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Social media applications are the most popular web and mobile applications across the globe. In the meantime, however, this has resulted in the emergence of conflict and hatred by making online environments, particularly Twitter, uninviting for users. This issue typically affects individuals, organizations, and governments because it can have a reasonable or unreasonable impact on someone's reputation, as well as trigger discrimination, hostility, and violence, which can lead to or include terrorism or atrocity crimes in society. Therefore, an accurate, efficient automatic model to detect and classify terrorist speech on Twitter is a very useful tool for the relevant authorities. This paper describes the detection and classification of terrorist speech on Twitter by using deep learning. This can fill in the gaps between current models with higher accuracy and reliability. Thus, this research is beneficial in various ways, such as the detection of terrorist speech in different categories, such as disagreement, negative actions, negative character, demonizing and in humanizing, violence and death. The developed application used deep-learning algorithms to find the number of occurrences of the words and the semantic words. Furthermore, LSTM model is used to train the data set and to get the probability values. The classes of terrorist speech were calculated against the training data set and were found to be above 70%. In conclusion, the developed method can help to detect and classify terrorist speech into six classes on Twitter.

Keywords: *Twitter, Terrorist Speech, Text Mining, Natural Language Processing*

Information Systems Applications in Quality Assurance of State Universities in Sri Lanka

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Following the global trend, Sri Lankan state universities focus on quality assurance of teaching-learning while standardizing the study programmes. Scholars have broadly discussed the prevailing issues of quality assurance activities of the higher education context. Accordingly, some of the quality assurance activities have become an additional burden for university staff. Although universities employ many information systems, their contribution to the quality assurance process is limited. The objectives of this study are to explore the information systems applications in the quality assurance context and the expected improvements of such information systems to cater for the quality assurance process. An online questionnaire was used to collect the respective data from the staff of the 13 state universities from January to May 2021. According to the results, information systems can be employed to provide required evidence for quality assurance reviews and facilitate quality assurance activities. But existing information systems need more improvements to cater for the quality assurance requirements such as information provision and facilitate the quality assurance activities. Accordingly, this study concludes the necessity of more improvements of existing information systems to facilitate the quality assurance requirements.

Keywords: *Quality Assurance, Higher Education, Information System*

Strengthening the Technovation Generation and Dissemination Links among the Key Stakeholders of Internationalized Public Private Partnership Extension Approach: Lessons Learnt from Internationalized Tech-based Tea SMEs in Matara and Rathnapura Districts of Sri Lanka

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In the process of agricultural extension, the technology generation is usually undertaken by the state sector research institutions where, with the privatization of the state plantations and the rapid growth of the internationally oriented tech-based tea TSMEs sector, the tech-innovation generation and dissemination system have both the private and public operating through a variety of channels. This empirical study enlightens the present collaborations among the key stakeholders on ideal technovation generation and dissemination in the Internationalized Tech- based Tea SMEs through identifying the potentials and boundaries for the effective establishment of linkage mechanism of globalized public-private partnerships. Multi-stage Stratified cum Purposive Sampling techniques were applied to compile essential information from 135 selected stakeholders from two districts which analyzed using SPSS software package. A reasonable educated background is depicted by the internationally oriented private and public extension staff which ensures a high level of contacting ability plus opportunity to technically empower them; emphasizing that there is a lack of global orientation within both the private and public extension staff. The social positions of the majority of internationalized private and public extension personnel are high while the social participation of internationalized Tech- based Tea SME owners is also high. Feedback information flow from private extension channels and internationalized Tech- based Tea SMEs towards the public information sources is poor and should be strengthened to identify the technical desires and areas of refining the technology. Hence, making horizontal as well as vertical interrelation among key domestic with very few international partners of both the private and public extension channels would help to strengthen the information flow on average. The level of perceived international partnerships was also positively correlated with the yield, respondent's experience and social participation of internationalized Tech- based Tea SMEs. A greater concern on international orientation and interaction among key stakeholders in planning, implementation and monitoring of the programs, effective communication, International Corporation and mutual respect among the staff of the partner organizations are of paramount importance in maintaining an effective globalized private public partnership extension approach.

Keywords: *Internationalized Tech-based Tea SMEs, Internationalizing Perception, Internationalized Public-Private Partnership Extension Approach*

Engineering Technology

Investigation of Frequency Evolution of Gravitational Waves From Core Collapse Supernova by Hilbert-Huang Transform

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The next generation Gravitational Wave (GW) detectors are expecting to detect GWs from Core Collapse Supernova (CCSN). Numerical studies show two processes related to the GWs from CCSN; Oscillation of Proto Neutron Star (PNS) (Eigen modes) and Standing Accretion Shock Instability (SASI mode). The physical properties of PNS can be estimated by the analysis of GWs with the approach of the asteroseismology. For which, time evolution of frequencies of eigen modes should be separately identified on the time-frequency representation. However, the conventional method such as Short Time Fourier Transformation (STFT) is not effective due to their low-resolution nature. As the solution, Hilbert Huang Transformation (HHT) is applied. This research consists of two objectives; Comparison of resolution of STFT and HHT and Investigating the ability of HHT to identify the frequency trending. In this research there are two time series models, Time Independent (TI) and Time Dependent (TD), have been considered for the analysis instead of the time series of GWs from CCSN. To perform the analysis, both STFT and HHT are applied on TI and TD time series separately under three different Signal to Noise Ratios (SNR); 5,10 and 20. In the HHT analysis, both Empirical Mode Decomposition (EMD) and Ensemble Empirical Mode Decompositions (EEMD) have been used. According to the results obtained by the analysis, it has been concluded that the resolution of the HHT is higher than that of to the STFT. In the HHT analysis, it has been compared the theoretical frequency trending of the TI and TD models with the Instantaneous Frequency (IF) trending obtained by the HHT analysis. And also, HHT map has also been generated to identify the frequency trending. According HHT results,it has been concluded that HHT is effective to identify the different mode frequencies to estimate the physical properties.

Keywords: *Core Collapse Supernova, Hilbert Huang Transform*

Reliability Comparison of Weather Data of PVGIS, NREL and Solcast for PV Solar Energy Generation Forecasting

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The research work presents a comparative analysis of several weather data providers in solar Photovoltaic (PV) energy forecasting to investigate the most accurate weather data provider for solar PV energy forecasting. This study uses PVsyst commercial software, the most popular solar energy forecasting software in Sri Lankan industries. For this study, researchers have focused on a solar power station situated in the Anuradhapura region, Sri Lanka. This comparative study has been carried out using three different weather data providers.The study has compared actual energy generation of the solar power station within six months with simulations based on PVGIS, NREL, and Solcast international weather data sources. However, Solcast has given a minor error (6.1% per half-year) compared with the other two data sources (-13.2% for PVGIS and 12% for NREL per half-year). According to the results, all of the above data create an error that cannot be neglected. However, when considering a feasibility study of establishing a solar PV station, this result will be helpful in approximate forecasting of the PV energy generation.

Keywords: *Photovoltaic, Solar Irradiance, Forecasting, Power Generation, Weather Data*

A Method for Warning with Visually Impaired People Using the Vibrational Technology in Smart Phones

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Visually impaired people are the ones who are unable to read the world and they are facing more troubles when using modern technologies such as smart devices (Mobile devices, Smart phones). When using mobile devices, sometimes they will not be able to identify important messages such as news alerts. But with the help of modern technologies such as word analyzing using Natural Language Processing it has become possible to track those messages. Modern mobile devices are powerful and have more processing power and those are embedded with technologies such as vibration technology, sensors, and Powerful cameras. Most visually impaired people are not much interested in using mobile phones because there are no proper mechanisms that fit them. If using a method like reading the messages louder, that could be useful because they can hear properly. But that can affect the privacy of those people. If we can use vibrate technology for communication, it can be more effective for those people because they can feel the pattern easily. If they receive an emergency notification, such as a natural disaster, they would be able to identify the message by analyzing the vibrate patterns. This research has used the vibrating technology in smart phones to inform about some emergency messages to visually impaired people. An inbuilt analyzing model will help to filter some messages that are not dangerous and then the most wanted and informative messages will be given as Morse code pattern, and it will help to maintain the lifetime of the vibration motor. By analyzing the vibrate pattern with the aid of Morse code the visually impaired people can identify whether the message is a dangerous one or not. So, this will be very useful for those people because they can get informed about the important information mainly regarded to their safety

Keywords: *Visually Impaired, Word Analyzing, Artificial Intelligence, Natural Language Processing, Morse Code*

Thermal Conductivity Measuring Sensor Using Arduino Microcontroller

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Most of the industries pay high priority to their packing materials. Properties of packing materials in food industry, mainly depend on the food type. In some fields such as fresh-milk, frizzed-food and Ice transportation services care about temperature condition in their production. In present thermal conductivity is measured using probe method using a probe.But this method is not suitable for high accuracy, and it can use only for thick materials. A thermal conductivity measuring method for a thin layer is not available. This attempt is to find out suitable method to measure thermal conductivity for a thin layer materials. This system can be divided into two parts, first part is hardware and the second part is a software. For this project Arduino UNO programmable board was used, and the relevant algorithm control the output components. Due to the change of the sensors' environment and user inputs, transferring signal read by the microcontroller and change relevant outputs. This project has presented a means of measuring the thermal conductivity of matters with an embedded microcontroller system. Specifically, it demonstrates working with measuring thermal conductivity of thin layers. This project also simplifies the device operation of user than available products. Cost effectiveness is a great advantage of this project.

Keywords: *Temperature, Thermal Conductivity, Embedded Arduino Microcontroller*

A Sustainability Assessment Model for Prefabricated Building Construction Projects in Sri Lanka

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The growing concern for sustainable construction and innovative approaches has emerged to reduce the negative impacts that exist due to the implementation of conventional construction methods such as high cost and environmental impacts. Prefabrication is an alternative approach to traditional construction that considers the adverse effects of conventional construction and offers practical solutions to overcome those issues. Due to the existing economic, environmental and social barriers in the prefabrication projects, it is struggling to meet certain requirements needed to achieve sustainability. Consequently, there is an emergent need for a proper sustainability assessment system for prefabricated building projects. However, there are no research activities that consider the economic, environmental, and social aspects of prefabricated building construction projects in Sri Lanka. Accordingly, this research focuses on developing a model to assess the sustainability of the prefabricated building projects in Sri Lanka. Since this research evaluates the importance of sustainability indicators in prefabricated building construction projects, a quantitative research approach was selected. Literature synthesis was carried out to identify the sustainable evaluation criteria that fit the prefabricated construction projects. The specified evaluation criteria include the "Triple Bottom Line (TBL)" sustainability indicators and Sustainability Performance Indicators (SPIs). Subsequently, the questionnaire survey was conducted to identify the prominence of each evaluation criterion. Analytic Hierarchy Process (AHP) calculated the relative performance score of TBL sustainability indicators and the SPIs.The key findings derived through data analysis revealed that the economic indicators obtained the highest relative performance score. At the same time, the cost-efficiency indicator obtained the highest relative among all SPIs. The sustainability assessment model for prefabricated building projects was then developed with the help of derived performance scores. The developed model is derived as the research outcome, which may assist individuals, organizations, and construction industry practitioners assess the sustainability of prefabricated building construction projects in Sri Lanka and other similar contexts.

Keywords: *Sustainable Construction, Prefabrication, Triple Bottom Line (TBL), Sustainability Performance Indicators (SPI)*

Design and Fabrication of a Single Belt Dual Purpose Telescopic Conveyor

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Currently many industries are moving towards smart, compact, and cost-effective devices with high efficiencies over traditional machineries. In every manufacturing process, material handling plays a major role and normally these operations are carried by belt conveyors. When considering about the current versions of conveyors used in industries, most of them are fixed to factory floors which occupies larges spaces of the plant and unidirectional. So, these types of traditional conveyors cannot be used for both loading and unloading applications. These belt conveyors are not still developed as separate products because in many materials handling processes these conveyors are developed as integrated products. Therefore, in this research a novel portable bidirectional telescopic conveyor that can be used for both loading and unloading was proposed to overcome deficiencies of traditional belt conveyors. The proposed conveyor also equipped with remote control and smart features for inventory management and can be further developed as a part of real time inventory monitoring system. Cascading chain mechanism and only a single belt used in the developed conveyor design to move conveyor beds. Single belt operation was achieved by a series of roller placement inside the conveyor that moves when the telescopic conveyor is in an extending or retracting motion. The proposed telescopic conveyor was tested by fabricating 1:5 scale prototype with other essential features. During the testing for stability and structural integrity of the proposed system both chain and chain mechanism smoothly without any failures. Therefore, the proposed telescopic conveyor is a cost effective and efficient replacement for traditional conveyors for both loading and unloading purposes.

Keywords: *Efficiency, Inventory, Loading, Reduced Manpower*

Development of Novel Activated Carbon Composite Material Derived from Coconut Shell and Natural Clay for Water Purification

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Deterioration of water quality becomes one of the major issues in the world as a result of anthropogenic activities on the environment. Higher levels of contaminants in drinking water lead to chronic health effects for humans, such as cancer and liver and kidney damage. Adsorption has become a well-established water treatment technique due to its low cost, high efficiency and eco-friendliness. The present study presents a method for removing contaminants in drinking water by using the novel physically activated carbon composite developed from locally available kaolinite, montmorillonite and coconut shell activated carbon. Spherical shape activated carbon composite material with 5 mm diameter was synthesized by mixing a 1:1:1 ratio of montmorillonite, Kaolinite and coconut shell charcoal. Heat treatment for the spheres was carried out in the muffle furnace at 900 ^{0}C for 1 hour. The composite material was characterized using Fourier transform infrared spectroscopy (FTIR) and X- ray diffractometry (XRD) to investigate the structural properties. The adsorption capacity of the composite was calculated using Freundlich and Langmuir isotherms with an aqueous iron (II) solution of concentration range 10-25 mg L^{-1}. Results suggest that experimental values were fitted well into the Freundlich isotherm, indicating the multilayer adsorption. The Freundlich constants kf and n values obtained were 0.0066 mg g^{-1} and 0.6483 L mg^{-1}, respectively. The 2g of activated carbon composite material showed the maximum removal efficiency of 60% within 90 min at 50 ^{0}C from an iron solution of 10 mg L^{-1}.

Keywords: *Adsorption, Composite, Kaolinite, Montmorillonite*

Film Properties of Pre - vulcanized Natural Rubber Latex Films Produced out of Creamed Latex

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Pre - vulcanization of latex yields latex with intra cross-linked rubber molecules in rubber agglomerated dispersed in the aqueous medium. This nature of latex offers many advantages such as improved stability, simplicity in use, long shelf life, low toxicity in the industrial applications. In this research study, pre-vulcanization of natural rubber creamed latex using fast, ultrafast and delayed-action accelerator systems was investigated. Accelerators used were Tetramethylthiuram disulfide, Zinc diethyldithiocarbamate and N-Tert-Butyl-2-benzothiazolesulfenamide, respectively. Corresponding counterparts were also prepared using centrifuged latex for the purpose of comparison. Pre-vulcanized latex films were prepared and their film properties were compared. Results showed that latex films made out of pre-vulcanized creamed latex exhibit higher crosslink density as evidenced by the lower swelling index, higher tensile strength (unaged and aged) and tear strength values than the corresponding films prepared using pre-vulcanized centrifuged latex. These results were justified by the low level of curing agent residuals available in the pre-vulcanized creamed latex than the centrifuged latex counterpart as evidenced by the acetone extraction results. Further pre-vulcanized creamed latex possesses low leachable protein content before leaching than that of in centrifuged latex. However, after leaching the opposite trend was observed, with significantly low levels of leachable protein content. Among the candidate accelerators, Zinc diethyldithiocarbamate accelerator showed overall best performance while the lowest performance was shown by N-Tert-Butyl-2-benzothiazolesulfenamide. Therefore, it could be inferred that pre-vulcanized creamed latex with ultra-fast accelerator system can be a new achievement for the small scale rubber product manufacturers assuring energy efficient and less chemical consuming process promoting greener rubber products.

Keywords: *Accelerator, Centrifuged, Creamed, Pre-vulcanized*

Machine Learning

Classification of Letters for Sri Lankan Universities Using Text Mining

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Many government agencies formally communicate with letters as an integral part of their operational activities. Disposition of those letters among departments, units and personnel is vital due to volume, urgency and confidentiality of the communication. Information technology plays a tremendous role accelerating data processing and document processing in every aspect of our day to-day life. Therefore this study focuses on increasing efficiency of letter disposition using Text processing techniques in Sri Lankan universities where most of the formal communication happens through written letters in operational activities of their general administration. Addressing the efficiency of letter sorting and to speed up decision making process, this study propose a systematic process for automatically clustering letters into different groups and identifying the cluster of those letters by analyzing content written on letters. Using RapidMiner studio and Monkey Learn platform we have developed two models to clustering letters and identifying type of the letters. A Sentiment Analysis Model is used to identify specific keywords in order to determine the cluster type and using K means algorithm letters were clustered into identified groups. Before applying letters into the clustering process, we preprocessed letters by using different text-preprocessing techniques such as transform case, tokenize, prebuilt dictionary and different filtering techniques were used to keywords utilization. Initially we have used forty letters which are consisting of eight thousand words as our test data set which were collected from different universities and faculties in Sri Lanka. After the data collection we categorized letters into four groups named as academic, canteen, hostel and extra activities by crowdsourcing. Proposed clustering algorithm clustered all the letters into the four pre-defined groups with a 90% of accuracy leading effective categorization of letters in an organization. Finally, we found the type of the letters using the prebuilt Sentiment Analysis Model with 83% of accuracy.

Keywords: *Text mining, Clustering, Sentiment Analysis*

Convolutional Neural Network Based Approach for Identification of Black Ruby Barb

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The basis for all aspects of taxonomic research is to identify the species accurately. So, Biologists are searching for more efficient methods to achieve the identification demand. Among the rapid increase in biological image data and the induction of artificial intelligence, modern machine learning techniques such as deep learning, plays a vital role in automated species identification. Such species are birds, snakes, fungus, frogs, fishes and etc. Traditional approach of fish species identification is expert based. It is time consuming. And also it tends to make errors for those who are not expert in that field and when the size of the sample is increased. In this paper we propose a Convolutional Neural Network (CNN) based fish identification method to identify the Sri Lankan endemic fish species namely Black Ruby Barb (*Puntius nigrofasciatus*). The training dataset consists photos taken from natural environment and images from the Internet. Since image dataset of Black Ruby Barb is not easily available, we used data augmentation transformation to generate more learning samples. The CNN model was trained by using 90% of labeled images and tested by using 10% of labeled images from the total dataset which contains images of Black Ruby Barb in various poses, rotations, and scales. The obtained results show that our approach achieved 89% accuracy and 79% accuracy for training and testing phases respectively. The proposed CNN based method has a promising performance for identification of Black Ruby Barb and has the potential to be extended to other fish species

Keywords: *Black Ruby Barb, Convolutional Neural Network, Deep Learning, Fish Identification*

Data Mining in Education: An Approach in Predicting Employability of Undergraduates using Naïve bayes classification Algorithm

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Graduate employability is a crucial concern to all countries in the world. Many graduates are looking for job opportunities despite their qualifications and skills. Therefore, predicting the employability of an undergraduate considering their performances has become a timely requirement as it can help address unemployment in great success as it provides students an opportunity to groom. This research analyses demographic and educational factors affecting an individual's employability and develops a model to predict an undergraduates' capability of achieving career targets beforehand. This study further addresses the measures and methods that can predict the skills and competencies of individuals required to be employed. Data mining methods are often implemented nowadays for analysing available data and extracting information and knowledge to support decision-making in various domains, and in this study, the Naive Bayes classification algorithm is used by considering the method's advantages to predict the possibility of undergraduates' employability. This paper presents the results of potential employability of undergraduates using demographic and educational information collected via an online survey conducted through social media platforms using the naïve Bayes classification algorithm. Apart from demographic factors, undergraduates' lecture participation rate, computer literacy, English literacy, intern participation, club memberships, and many more attributes were used to evaluate their competencies. Overall, individuals who have an active involvement with academic activities, including extra-curricular activities, were more likely to be predicted as employed. Therefore, using the naïve Bayes classification algorithm, the most influencing factors that can be used to predict undergraduates' employability are presented by using a trained model with graduate data with an accuracy of 75.89 %.

Keywords: *Data mining, Data classification, Naive Bayes, Graduate Unemployment*

Predictive Analysis of Ceylon Cinnamon Market Price Fluctuations Using Artificial Neural Networks

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Considering the demand for Sri Lankan Cinnamon in the world market, it is important to look at the economic status of Sri Lankan crop growers. Today, Sri Lanka is a leading exporter of Ceylon Cinnamon, Ceylon Pepper, Ceylon Cloves, Ceylon Nutmeg and Ceylon Cardamom, all branded under the geographical indication of Ceylon Spices due to their unique aroma and flavour shaped by the territory of the country. It is important for crop growers to be aware of the price changes happened in past as well as it is important to know how prices are going to fluctuate in the coming years. The Cinnamon market makes purchases at different prices over the same period of time when it is observed across geographical locations within the country. Thus, these growers are still suffering due to the unavailability of correct prices to sell their crops. The economic status of those growers has not changed over years and research revealed that it is mainly due to growers not knowing the correct prices, different traders buying crops at different prices, and traders and growers not having an accurate understanding of prices. Therefore, this study focuses on encouraging small export crop growers in Sri Lanka to boost Sri Lanka's foreign exchange reserves by providing them a better understanding of their market prices in terms of buying and selling. This research predicts cinnamon price fluctuations using artificial neural networks with 94% accuracy for Alba grade in 10 cinnamon growing districts in Sri Lanka using past prices of 2016 to 2020. Results show that Artificial Neural Networks predict the price changes in a higher precision than other statistical methods used to predict cinnamon market prices.

Keywords: *Cinnamon Market price, Neural Networks, Ceylon Cinnamon, Price Prediction*

Guidance on Selecting Promising Business Ideas through Machine Learning

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Businesses and Entrepreneurship have a significant impact on a country's economy. However, due to various reasons, including increased competition in the business sector, the business success rate has been decreased. Selection of a suitable business will play a significant role in improving their success rates. However, due to poor knowledge and lack of experience of businessmen, the business selection will be critical. This study will introduce a model as a solution to the above-mentioned problem, which helps to assist with business selection. Furthermore, this model attempts to evaluate the likelihood of achieving success in a particular business opportunity that someone is willing to start. To identify important factors with a critical impact on business success, experts in related industries have been consulted and meanwhile, a comprehensive literature review has been conducted. Then these identified factors were used to prepare a structured questionnaire to collect data from people in several business sectors. During the model development, a higher level of data pre-processing was conducted to make the model result more accurate and realistic. Additionally, the knowledge gained from experts and literature was used to prioritize the factors into several levels and weights according to their impact on business success. The initial weights were assigned using the fuzzy logic method and then the weights were fine-tuned by experimenting on a simulation tool. Moreover, different types of machine learning algorithms were used to experiment with extracting various business patterns. Finally, by comparing the results and the applicability of factors, the K-Nearest Neighbour approach was used to complete the model and achieved the expected results with 87% of accuracy. Ultimately, this model was combined with the simulator tool to allow the users to enter relevant factors as the input and to receive appropriate business ideas and levels of feasibility as the output. This study will contribute to enhance the machine learning applications in the business sector and aid novice businessmen in starting up their businesses.

Keywords: *Business Success Factors, Machine Learning, Business Selection, Pattern Recognition*

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Prof. Mohamed Esham
Editor-in-Chief
The Sabaragamuwa University Journal

'Sabaragamuwa Viśvavidyālīya Śāstrīya Samgrahaya'

The Sabaragamuwa University Journal

One of the key points that emerge when looking at the Sri Lankan university system is that the majority of academic journals are published in English. 'Sabaragamuwa Śāstīya Sagrahaya', the Sabaragamuwa University Journal is a refereed journal that has been published continuously for many years, at a time when there are few academic journals to impart knowledge in Sinhala, providing scholars with a great opportunity to share knowledge gained through their research. It is evident from the academic articles we receive that the intellectuals are paying special attention to this academic journal. All such academic articles are referred to a panel of experts and published in a systematic manner in accordance with their recommendations. Given the current world scenario, in which the entire humankind is undergoing through a period of immense tragedy, conducting more research would be beneficial to the present and the future researchers as well. Moreover, it would be more meaningful to explore knowledge at a time when we are experiencing the emptiness and inferiority of human life in compared to nature. As the focal point of researching knowledge in the Sabaragamuwa Province, the main aim of our University is to dedicate such quality and meaningful academic journals to the nation to impart new knowledge in different fields of study. This journal in the Sinhala medium demonstrates the commitment of the University in its academic endeavors.

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